An investigation into the effectiveness of two different taping techniques in the treatment of plantar fasciitis

By

Justin L. Petzer

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Durban University of Technology

I, Justin L. Petzer, do declare this dissertation is representative of my own work in both conception and execution (except where acknowledgements indicate to the contrary).

Signed: ______________________ Date: _______________________

J. L. Petzer

Approved for Final Submission

Signed: ______________________ Date: _______________________

Dr G Matkovich, M.Tech: Chiropractic

<u>DEDICATION</u>

Mom, thank you for always being there for me – this is for you.

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ABSTRACT

Background: Plantar fasciitis (PF) is inflammation of the plantar surface of the foot, usually at the calcaneal attachment and is most commonly due to overuse. It is the most common foot condition treated by healthcare providers. Conservative treatment using taping is one of the first lines of treatment for PF. Low-Dye taping and Kinesio taping are two types of taping techniques commonly used to treat PF. Low-Dye taping and Kinesio taping have different intrinsic tape properties as well as different mechanisms of action in the treatment of PF. Low-Dye taping involves the use of a non-stretch, rigid tape. Rigid tape is commonly used by therapists primarily for the mechanical properties the tape provides to support the injured structure as well as to protect against re-injury. Low-Dye taping shortens the distance between origin and insertion of the plantar musculature and fascia, decreasing stress and tensile forces along the plantar plate to protect the plantar fascia and allow healing to occur. Kinesio tape is an elastic tape that allows a one-way longitudinal stretch; it is applied in a specific manner to achieve its therapeutic effects and forms convolutions on the skin. The proposed mechanism of action of Kinesio tape involves improving circulation of blood and lymphatics to resolve oedema caused by the inflammatory component of PF; suppressing pain, and; relieving muscle tension to return fascia and muscle functioning to normal. Both forms of tape have shown effectiveness in the treatment of PF; however the effectiveness of one taping technique versus the other has not yet been explored.

Objectives: The purpose of this study was to determine the effectiveness of Kinesio tape alone versus Low-Dye tape alone in the treatment of PF in terms of both objective and subjective measures.

Methods: Thirty participants with a diagnosis of PF, between the ages of 20 and 45, were randomly allocated into two treatment groups. Both groups received treatment in the form of a taping technique, either Kinesio tape or Low-Dye tape. Assessments were made pre-treatment at each visit and at a follow up visit, with seven visits in total. Assessments included objective data measures (ultrasonography, algometer readings, weight-bearing ankle dorsiflexion measurements) and subjective measures (the visual analogue scale and the foot function index questionnaire). Data was recorded in a data collection sheet and Statistical Package for the Social Sciences version 21 was used to analyze the data with a p value of < 0.05 considered as being statistically significant.

Results: Most outcomes showed a significant improvement over time regardless of which form of treatment they received. For the VAS and pain walking outside, in the disability section of the FFI, there was statistical evidence of the Kinesio tape group improving more than the Low-Dye tape group. For morning pain, in the pain section of the FFI, and pain climbing curbs, in the disability section of the FFI, there was statistical evidence of the Low-Dye tape group improving more than the Kinesio tape group. For all the other outcomes there was a non-significant trend towards the Low-Dye tape group showing a greater improvement than the Kinesio tape group.

Conclusion: Kinesio taping and Low-Dye taping were both found to be effective in the treatment of PF with neither form of tape showing superiority to the other in the treatment of PF.

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DEFINITION OF TERMS

Algometer:	A pressure gauge calibrated in kg/cm2 used to measure pain pressure threshold of a patient at a certain painful or tender spot (Vanderweeën et al., 1996).
Graston Technique:	A specific soft tissue technique that utilises six curvilinear stainless steel instruments with double-bevelled edges to treat a variety of soft tissue conditions. May also be called Graston Technique Instrument-assisted Soft Tissue Mobilisation (Hammer, 2001).
Kinesio tape:	A specialised polymer elastic tape, wrapped with 100% cotton fibres and a medical grade acrylic adhesive, with proposed therapeutic benefits when applied correctly. Used in the treatment and prevention of injuries (Kase, Wallis and Kase, 2003).
Low-Dye tape:	A taping technique, using rigid zinc oxide tape, routinely used in podiatry and physical therapy for an array of foot pathologies (Saxelby, Betts and Bygrave, 1997).
Manipulation:	Passive manoeuvre in which specifically directed manual forces are applied to the vertebral and extra vertebral articulations, with the object of restoring mobility to restricted areas (Gatterman, 1990).
Oedema:	Increased fluid in the interstitial tissue spaces (Kumar et al., 2007).
Plantar fasciitis:	Inflammation of the plantar surface of the foot, usually at the calcaneal attachment (Stedman, 2005).
Trigger point:	A focus of hyperirritability found within a taut band of skeletal muscle or in its fascia that can cause local and referred pain (Travell and Simons, 1999).

Ultrasonography: The visualisation, measurement or delineation of deep structures of the body by measuring the reflection of high-frequency, ultrasonic waves. (Steadman's Medical Dictionary for the Medical Professions and Nursing, 2005).

LIST OF ABBREVIATIONS

ANOVA:	Analysis of variance
BMI:	Body mass index
CPPV:	Chiropractic Principals and Practice Five
DUT:	Durban University of Technology
ESWT:	Extracorporeal shock-wave therapy
FFI:	Foot Function Index
GISTM:	Graston Technique Instrument-assisted Soft Tissue Mobilisation
kg:	Kilogram
m:	Metres
MCID:	Minimally clinically important difference
MFTP:	Myofascial trigger point
MHz:	Megahertz
mm:	Millimetres
MRI:	Magnetic Resonance Imaging
MTPJ:	Metartarso-phalangeal joint
n:	Sample size
NSAID:	Non-steroidal anti-inflammatory drug
OTC:	Over the counter
p:	Probability
PF:	Plantar fasciitis
PPT:	Pain Pressure Threshold
PRP:	Platelet-rich plasma
SPSS:	Statistical Package for the Social Sciences
US:	Ultrasonography
VAS:	Visual Analogue Scale
WBDF:	Weight-bearing dorsiflexion

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CHAPTER ONE: INTRODUCTION

1.1 Introduction

Plantar fasciitis (PF) is the most common foot condition treated by healthcare providers (McPoil et al., 2008; Hunt et al., 2004) accounting for 15% of all foot disorders (Sorrentino et al., 2008) with more than 10% of the population affected by it over their lifetime (Hossain and Makwana, 2011; Puttaswamaiah and Chandran, 2007). It accounts for 7-14% of sporting injuries (Fabrikant and Soon Park, 2011; Batt and Tanjii, 1995; Ambrosius and Kondracki, 1992; Noakes, 1985) and is especially prevalent in sports requiring a 'push off' motion (Batt and Tanji, 1995). PF is also known as 'the painful heel syndrome' and occurs in both males and females with a higher predominance in young male athletes (Hossain and Makwana, 2011) and middle-aged obese females (Hossain and Makwana, 2011; Barrett and O'Malley, 1999; Brown, 1996).

PF is primarily an overuse injury (Hossain and Makwana, 2011; Batt and Tanji, 1995) and involves inflammation of the fascia on the plantar surface of the foot and micro-tears of the plantar fascia at its insertion on the calcaneus (Barrett and O'Malley, 1999; Lillegard and Rucker, 1993) following tensile overload (Batt and Tanji, 1995; Kibler, Goldberg and Chandler, 1991). The body's attempt to heal these micro-tears can lead to chronic inflammation and the formation of adhesions (Puttaswamaiah and Chandran, 2007; Ambrosius and Kondracki, 1992). The most common presenting symptom of PF is a sharp pain of insidious onset with maximal tenderness at the anterior medial border of the calcaneus (Hossain and Makwana, 2011; Puttaswamaiah and Chandran, 2007; Hunt et al., 2004; Batt and Tanji, 1995). The pain is typically worst on the first few steps in the morning (Hossain and Makwana, 2011; Puttaswamaiah and Chandran, 2007; Brantingham et al., 1992) and with initial steps after prolonged sitting or inactivity (Puttaswamaiah and Chandran 2007; Hunt et al. 2004).

There are many different treatment techniques to treat PF (Hossain and Makwana 2011; McPoil et al. 2008; Hunt et al., 2004; Rajput and Abboud 2004; Barry, Barry and Chen 2002; Noakes 1985). Treatment usually involves conservative management; if this fails a non-conservative approach like surgery can be used. Conservative management employs many different techniques including: rest (Batt and Tanji 1995), cryotherapy (Nicholas and Hershman 1995), therapeutic ultrasound (Pollard and So 1999), stretching and strengthening (Young, Rutherford and Niedfeld 2001), manipulation (Brantingham et al., 1992), orthotics (Young, Rutherford and Niedfeldt, 2001), strapping (Hunt et al., 2004) and night splints (Batt and Tanji, 1995) all of which have been shown to be beneficial. Surgical release of the plantar fascia should only be considered if there is no response following six to nine months of conservative treatment (Hormozi, Lee and Hong, 2011; Young, Rutherford and Niedfeldt, 2001; Nicholas and Hershman, 1995; Ambrosius and Kondracki, 1992). A plantar fasciotomy can be performed using open, endoscopic or radiofrequencing techniques (Young, Rutherford and Niedfeldt, 2001). Although effective there can be a risk of complications following surgery, such as rupture of the plantar fascia, damage to the tibialis posterior nerve or heel hypoesthesia (Guijosa et al., 2007).

Conservative treatment involving the use of strapping or structural correction is a first line intervention for PF treatment (Hunt et al., 2004; Rajput and Abboud, 2004). Several authors agree that Low-Dye taping of the foot is effective in the treatment of PF (Bagewadi, Santosh and Ganesh, 2010; Hunt et al., 2004; Saxelby, Betts and Bygrave, 1997; Ryan, 1995; Chandler and Kibler, 1993; Brantingham et al., 1992). According to Yale (1987) immobilisation by Low-Dye taping shortens the distance between origin and insertion of the plantar musculature and fascia relieving the strain and tensile forces on weight bearing. In this way the strapping aims to allow healing to occur naturally (Hunt et al., 2004; Ambrosius and Kondracki, 1992).

Kinesio tape is a thin elastic tape invented by Kase in the1970s (Kase, Wallis and Kase, 2003). It is widely used to prevent injuries in athletes and it has a number of proposed beneficial properties. Tsai, Chang and Lee (2010) showed that taping with Kinesio tape, in addition to traditional therapy, was more effective in the treatment of PF than traditional therapy alone. The proposed mechanisms by which Kinesio tape works are different to those of traditional taping. Rather than being structurally supportive Kinesio tape is therapeutic in nature and the proposed mechanisms include (Kase, Tatsuyuki and Tomoki, 1996):

1. Correcting muscle function by strengthening weakened muscles.
2. Improving circulation of blood and lymph by eliminating tissue fluid (oedema) and bleeding beneath the skin therefore decreasing swelling.
3. Decreasing pain through neurological suppression.
4. Repositioning subluxed joints by relieving abnormal muscle tension, helping to return the function of fascia and muscle.

Therefore Kinesio tape can be used to correct the muscle function of the plantar musculature, aid with the resolution of oedema, decrease pain and hold the fascia in the desired position by aiding/stimulating movement in contrast to the traditional Low-Dye taping that is used to immobilise the plantar fascia to promote healing. Essentially completely opposite functions of the two types of taping achieve the same desired effect, which is resolution and healing.

In practice clinicians might utilise one form of taping or the other. However this choice may not necessarily be based on clinical significance but rather on aesthetics, comfort, fit into shoe, patient activities, and not on the relative effectiveness of the method of taping and the tape itself. There is a paucity of literature comparing and contrasting the Low-Dye taping with Kinesio tape taping with regard to which is more effective in the treatment of PF. Both Du Plessis (2002) and Brantingham et al. (1992) stated that there is a need for more research into the treatment of PF, especially in terms of each different modality or treatment used. Therefore there is an opportunity for research to be conducted into which taping technique is more effective in the treatment of PF.

1.2 Aim of the study

The aim of the study was to investigate the effectiveness of two different taping techniques in the treatment of plantar fasciitis.

1.3 Objectives of the study

Objective One

To determine the relative effectiveness of Kinesio taping versus Low-Dye taping in participants with plantar fasciitis in terms of objective measurements (algometer, weight-bearing dorsiflexion [WBDF] and ultrasonography).

Objective Two

To determine the relative effectiveness of Kinesio taping versus Low-Dye taping in participants with plantar fasciitis in terms of subjective measurements (visual analogue scale [VAS] and foot function index [FFI]).

Objective Three

To compare the relative effectiveness of Kinesio taping versus Low-Dye taping in participants with plantar fasciitis in terms of trends between the objective measurements and subjective measurements.

1.4 Rationale

PF is the most common foot complaint in adults (Hunt et al., 2004). Treatment usually involves conservative management initially and should that fail a non-conservative approach like surgery is used.

Numerous studies have been conducted investigating the surgical and medical treatment protocols in the treatment of PF (Hormozi, Lee and Hong, 2011; Nicholas and Hershman, 1995; Ambrosius and Kondracki, 1992). Conservative treatments of PF have not been fully explored; both Du Plessis (2002) and Brantingham et al. (1992) stated that there is a need for more research into the treatment of PF, especially in terms of each different modality or treatment used. However, Kinesio taping (Tsai et al., 2010; Kase, Tatsuyuki and Tomoki, 1996) and Low-Dye taping (Bagewadi, Santosh and Ganesh, 2010; Hunt et al., 2004; Saxelby, Betts and Bygrave, 1997; Ryan, 1995; Chandler and Kibler, 1993; Brantingham et al., 1992) have both been shown to be effective forms of treatment for PF. There appears to be no research comparing and contrasting the two treatments. As chiropractors the focus is on a drug free non-surgical approach to treating disease and injury therefore, this study aimed to determine the effectiveness of a conservative/drug free management in the treatment of PF. The knowledge gained on the effectiveness of Kinesio taping versus Low-Dye taping, and which is the superior form of strapping for PF, may assist the practitioner in achieving a greater level of success in their treatment of PF.

1.5 Organisation of the dissertation

Chapter Two will review the literature on PF, Kinesio taping and Low-Dye taping.
Chapter Three will describe the methodology used in the study.
Chapter Four will present the results of the study.
Chapter Five will discuss the results of the study.
Chapter Six will be the conclusion and recommendations of the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter presents the most current literature available on PF. PF will be defined, the anatomy of the plantar fascia will be described and discussed. The incidence, prevalence and epidemiological statistics will be explored as will the aetiological factors, clinical presentation and diagnosis protocols of PF. The possible differential diagnoses and current treatment options will be discussed, especially Kinesio taping and Low-Dye taping.

2.2 Definition

Plantar fasciitis is described as inflammation of the plantar surface of the foot, usually at the calcaneal attachment (Stedman, 2005). This is most commonly due to mechanical overuse (Daniels and Morrell, 2012) however it can also have a degenerative or systemic cause (Bygrave, Betts and Saxelby, 1997. This common disorder is found in both athletes and non-athletes (Batt and Tanji, 1995), old and young individuals (Brown, 1996) and both males and females (Landorf and Menz, 2007).

The patient characteristically complains of a sharp pain, insidious onset, localised to the heel over the anterior medial border of the calcaneus with pain typically worst on the first few steps in the morning (Hossain and Makwana, 2011; Magee, 2008; Hunt et al., 2004; Batt and Tanji, 1995). The pain is caused by collagen degeneration associated with repetitive micro tears of the planter fascia (Young, Rutherford and Niedfeldt, 2001).

2.3 Anatomy

The plantar fascia is a tough, broad, multi-layered fibrous aponeurosis comprised of mainly type 1 collagen (Daniels, 2003). As can be seen from Figure 1, it runs along the plantar surface of the foot from the inferior heel to the toes (Roxas, 2005). It originates at the anterior and medial aspect of the calcaneus as a thickened mass of longitudinally arranged collagen fibres, before spreading into a broad sheet as it extends distally towards the toes. In doing so it helps to form the longitudinal arch of the foot. It divides into five digital bands at the metotarsalphalangeal joints. Each digital branch divides to pass on either side of the flexor tendons of the toes before ending by inserting into the periosteum at the bases of each of the proximal phalanges (Lee and Maurus, 2007; Banks, 2001;). Small plantar nerves are invested in and around the plantar fascia, acting to register and mediate pain (Young, 2012). Fibres of the plantar fascia also blend with the dermis, transverse metatarsal ligament, flexor tendon sheaths, and other adjacent ligament structures (Lee and Maurus, 2007; Banks, 2001).

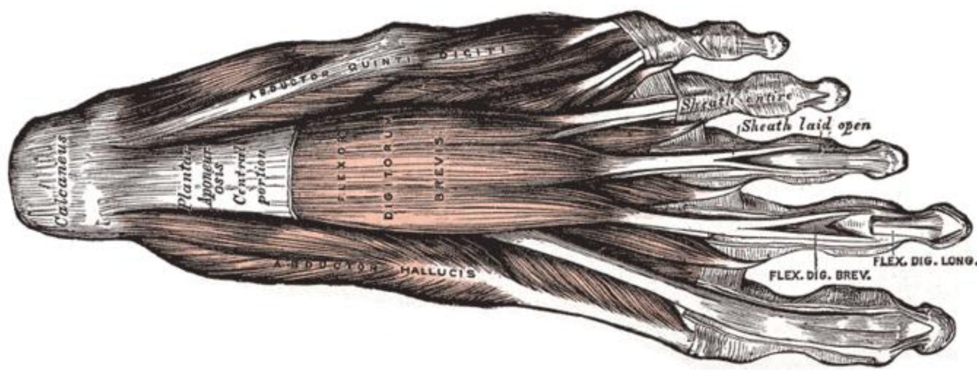

Figure 1: Plantar surface of the foot structure
(Gray, 1918: 329)

Strong vertical septa divide the plantar fascia into three portions; medial, central and lateral. The thickened central part is strong and lies between the thinner and weaker medial and lateral parts (Moore, 2004). The thick central part is the largest and most prominent and forms the strong plantar aponeurosis and is comprised of longitudinally arranged bundles of dense fibrous connective tissue investing the central plantar muscles (Lee and Maurus, 2007). This thickened central portion is the most likely to be involved with PF (Young, 2012).

The tough band of dense, fibrous connective tissue forming the plantar fascia has many functions. It provides static support of the medial longitudinal arch of the foot, which it also helps to form. It helps with protection of the foot, especially the sole of the foot, by acting as a dynamic shock absorber (Young, Rutherford and Niedfeldt, 2001) for the foot and entire leg (Roxas, 2005). The fascia itself covers the intrinsic musculature and neurovascular structures of the foot offering support and protection to these structures (Lee and Maurus, 2007)

2.4 Incidence, prevalence and epidemiology

According to Magee (2008) at least 80% of the general population have foot problems. PF is the most common foot condition treated by healthcare providers (McPoil et al., 2008). It accounts for 15% of all foot disorders (Sorrentino et al., 2008) and is widely accepted as the most common cause of heel pain (Barret and O'Malley, 1999; Pollard and So, 1999) with more than 10% of the population suffering from it in their lifetime (Hossain and Makwana, 2011; Puttaswamaiah and Chandran, 2007). PF accounts for 7-14% of sporting injuries (Fabrikant and Soon Park, 2011; Batt and Tanjii, 1995; Ambrosius and Kondracki, 1992; Noakes, 1985) and is an especially common injury in runners and athletes (Fabrikant and Soon Park, 2011; Noakes, 1985) affecting as many as 25% of athletes (Clement et al., 1981). PF can also occur in non-athletes (Batt and Tanji, 1995) where it has been shown to effect up to 10% of sedentary individuals (Ribeiro et al., 2011) as well as affecting the older population (Reid, 1992). Following a review of the literature Brown (1996) identified two groups of people more likely to present with PF: the first was elderly individuals aged 40-60, mostly woman with obesity often present. With the second group being athletes, mostly runners or those involved in sports with a 'toe-off' motion.

There is a higher prevalence of PF in woman than in men (Young, 2012; Morris, 2000; Hammond, 2000; Barrett and O'Malley, 1999 and Brown, 1996) however this sex predilection varies from study to study with some studies stating there to be no gender prevalence difference (Landorf and Menz, 2007) and others a male predominance (Ambrosius and Kondracki, 1992). Obese individuals are more likely to suffer from PF (Barrett and O'Malley, 1999; Brown, 1996 and Wolgin et al., 1994) as are individuals who spend prolonged periods of time on their feet (Young, 2012). Race and ethnicity play no role in the incidence of PF and it may be present bilaterally in a third of all cases (Young, 2012).

Individuals with chronic plantar heel pain experience significant disability including social isolation, poor perception of their health status, limitation of physical activity and exercise and lack of energy for daily tasks (Cotchett, Landorf and Munteanu, 2010).

2.5 Aetiology

The aetiology of PF is poorly understood and in approximately 85% of cases is unknown (Roxas, 2005). Most authors agree that PF is most commonly caused by overuse activities that place excessive strain on the plantar fascia (Young, Rutherford and Niedfeldt, 2001; Batt and Tanji, 1995) or poor biomechanics (Rajupt et al., 2004; Barret and O'Malley, 1999) that cause excessive foot pronation. This excessive pronation results in the load on the plantar fascia increasing beyond its anatomical capacity resulting in increased tensile forces and strain of the plantar fascia and causing PF (Kwong et al., 1988).

Many studies agree that PF is most likely the result of a combination of factors (Young, 2012; Roxas, 2005; Young, Rutherford and Niedfeldt, 2001; Batt and Tanji, 1995). According to Kibler, Goldberg and Chandler (1991) as well as Pollard and So (1994) these factors can be broken down into three broad categories namely: environmental, biomechanical and anatomical factors. These three categories are not mutually exclusive and often occur in conjunction with one another.

2.5.1 Environmental

With a high incidence of PF in runners, it is most commonly postulated to be caused by repetitive microtrauma (Young, 2012). In athletes the development of PF seems to be associated primarily with overuse (Roxas, 2005). Sudden increases in weight-bearing activity, especially those involving running lead to micro-trauma to the plantar fascia at a rate that exceeds the body's ability to heal and recover precipitating the development of PF (Roxas, 2005; Young, Rutherford and Niedfeldt, 2001).

Factors that contribute to overuse include: increased volume of activity, hill running, increased intensity e.g. speed work (Batt and Tanji, 1995; Reid, 1992), changes in equipment, increased duration of exercise (Kibler, Goldberg and Chandler, 1991), inadequate recovery time between training sessions, increased frequency of workouts, running on hard unyielding surfaces and running on a road with a camber (Johanson, 1992). Running on a road with a camber results in greater subtalar joint pronation of the uphill foot, with similar problems developing from running on a track, where the inside foot must pronate to a greater, potentially excessive, degree on the curved portions of the track (Johanson, 1992). This repetitive excessive pronation in both instances can result in excessive loads being placed of the plantar fascia and the development of PF.

Poor equipment, such as improper or excessively worn footwear is considered an important and often missed contributing and aggravator factor of PF (Rajput and Abboud, 2004; Ambrosius and Kondracki, 1992). Worn out shoes cause poor shock absorption and inadequate arch support to the foot, and excessively flexible shoes allow greater toe flexion and increased tensile forces in the fascia. Young, Rutherford and Niedfeldt (2001) state that, with age, running shoes lose a significant amount of shock absorbing capacity and that simply getting a new pair of shoes may be helpful in reducing symptoms of PF.

All these factors result in overuse of the plantar fascia as well as increasing the tensile strain causing overload at the fascial insertion of the plantar fascia precipitating inflammation and the development of PF (Batt and Tanji, 1995).

2.5.2 Biomechanical

Biomechanical factors leading to adverse biomechanics are one of the most common factors that precipitate the development of PF (Barrett and O'Malley, 1999; Noakes, 1985).

Hyperpronation, a biomechanical problem, is widely stated to predispose to PF (Roxas, 2005; Batt and Tanji, 1995; Kwong et al., 1998; Noakes, 1985). Batt and Tanji (1995) showed that excessive pronation leads to increased strain on the plantar fascia resulting in PF due to the prolonged midstance phase of gait. According to Roxas (2005) up to 86% of individuals with symptoms consistent with PF have excessive pronation. Laxity of the calcaneonavicular ligament (spring ligament), a key stabilizer of the longitudinal arch of the foot, can result in flattening of the foot and hyperpronation placing increased stress on the plantar fascia (Mansour, Teh, Sharp and Ostlere, 2008). A tight triceps surae or Achilles tendon and the associated limited ankle dorsiflexion can cause over-pronation and therefore predispose to the development of PF (Batt and Tanji, 1995). This is highlighted by Roxas (2005) who stated that the risk of PF increases as the range of ankle dorsiflexion decreases. Muscle imbalances between the subtalar and talocrural joints' inverters (tibialis anterior, tibialis posterior and flexor hallucus longus) and everters (peroneous longus and peroneus brevis) can lead to excessive pronation placing stress on the plantar fascia and causing PF. (Wang and Guitierrez-Farewik, 2011).

Hyperpronation tends to progress with age (Batt and Tanji, 1995). This is why PF is more common in the elderly (Young, Rutherford and Niedfeldt, 2001). Roxas (2005) states that PF occurring in the elderly adult is primarily biomechanical in nature, relating to poor intrinsic muscle strength, a result of the aging process, and poor force attenuation secondary to acquired flat feet (from weakened muscles and supporting structures) causing excessive pronation of the foot.

2.5.3 Anatomical

Anatomical variations and anomalies are changes to normal structure (Stedman, 2005). Structure governs function and according to Kumar et al. (2007) variations in the structure will therefore alter the correct function and can thus cause poor biomechanics which predispose to injury (Barret and O'Malley, 1999).

Anatomical risk factors that predispose to PF include: rigid pes planus or pes cavus, anatomic leg length inequality, lateral tibial torsion, increased femoral anteversion, talipes equinovarus and tarsal coalitions (Young et al., 2001; Pollard and So, 1994; Batt and Tanji, 1995; Kibler et al., 1991).

Leg length inequality results in a compensatory pronation on the long leg side predisposing to PF (Gurney, 2002). The rigid pes cavus foot with its high rigid arch and poor shock absorbing capacity is less able to absorb force and adapt to the ground resulting in greater stress being placed on the plantar fascia. Individuals with pes planus or flat feet formed mainly due to weakened ligaments and supporting muscles, force the plantar fascia to bear greater tensile loads than normal causing increased tensile stress on the plantar fascia which it is unable to dissipate on weight bearing activities (Roxas, 2005; Batt and Tanji, 1995). The externally rotated lower extremity, resulting from external tibial torsion or increased femoral anteversion, results in the stance foot being unable to supinate during mid and terminal stance phase so it pronates instead and the plantar fascia is subjected to a greater tensile loads which stresses it (Alghadir, 2006; Kwong et al., 1988).

2.5.4 Other

There are many other possible factors that may predispose to the development of PF. Recent studies have shown an association between obesity and developing PF (Young, 2012; Mcpoil et al., 2008; Roxas, 2005). A study by Irving, Cook, Young and Menz (2007) showed a higher BMI to be a risk factor to developing PF as obese individuals experienced higher vertical forces under the heel during gait leading to higher stresses within the heel damaging soft tissue structures like the plantar fascia.

Occupations requiring standing and prolonged weight-bearing have long been considered to have a higher risk of developing PF, due to the repetitive tensile load placed on the plantar fascia (Young, 2012; Roxas, 2005; Brown, 1996). Degeneration is another risk factor for PF development (Young, 2012). Heel pad atrophy as well as other age related degenerative changes increase pronation in the foot; this over-pronation increases the stress on the plantar fascia and increased the subsequent risk of PF (Young, 2012, Rajput and Abboud, 2004). Also, with the aging process the body has a decreased healing capacity as its ability to heal itself is surpassed by injury (Roxas, 2005; Young, Rutherford and Niedfeldt, 2001). This correlates to the increased incidence in PF in older individuals (Ambrosius and Kondracki, 1992).

Systemic disorders have also been linked to PF. These include: rheumatoid arthritis, gout, nutritional osteomalacia and the seronegative spondylarthropathies such as Reiter's syndrome, ankylosing spondylitis and psoriatic arthritis (Aldridge, 2004; Bartold, 2003; Barrett and O'Malley, 1999). Systemic disorders can be both precipitating factors and possible causes as they lead to changes in the muscular and bony structures of the foot (Rajput and Abboud, 2004).

2.6 Clinical presentation and diagnosis

At least 80% of the general population has foot problems, but these problems can often be corrected by the proper assessment, treatment and care of the feet (Magee, 2008).

PF is said to be a self-limiting condition (Young, Rutherford and Niedfeldt, 2001) known to be notoriously difficult to treat (Stephens, 2003) and the pain can persist for months or even years (Cole et al., 2005). The natural history of the disease is variable, said to be anything from as little as three (Ambrosius and Kondracki, 1992) to six months (Roxas, 2005; Young, Rutherford and Niedfeldt, 2001) and as much as eighteen (Roxas, 2005; Young, Rutherford and Niedfeldt, 2001) to twenty-four months (Murtagh, 2003). Early recognition, diagnosis and implementation of a good treatment plan usually results in a shorter duration of the disorder (Young, Rutherford and Niedfeldt, 2001).

A diagnosis of PF is made based on the patient's history and physical examination results (Cole, Steo and Gazewood, 2005). The most common presenting complaint is that of a sharp pain on the inferior heel, insidious in onset, with no association of acute trauma (Batt and Tanji, 1995). Most commonly the pain is described as being knife-like or stabbing in nature (Batt and Tanji, 1995) but may also be described as throbbing, searing, piercing (Cole, Seto, Gazewood 2005) or as burning initially (Genc et al., 2005; Batt and Tanji, 1995; Chandler and Kibler, 1993).

The pain is localised around the plantar surface of the heel but may extend along the entire medial portion of the plantar fascia and the fascial plane towards the metatarsals (Barrett and O'Malley, 1999; Ambrosius and Kondracki, 1992), depending on the severity of the condition. The classic sign of PF is that the worst pain occurs with the first few steps in the morning (Roxas, 2005; Young, Rutherford and Niedfeldt, 2001; Pollard and So, 1999; Brantingham et al., 1992; Reid, 1992). This 'start up pain' (Plantar fasciitis, 2010) often improves after further ambulation but worsens with continued activity and often limits daily activities (Cole, Seto and Gazewood, 2005). The pain is also more severe after prolonged periods of inactivity (Young, Rutherford, Niedfeldt, 2001). This pattern of pain is related to stiffness and contracture of the plantar fascia which subsequently eases during activity (Batt and Tanji, 1995). Pain may also be experienced by prolonged weight bearing such as standing and in more severe cases will worsen towards the end of the day (Plantar fasciitis, 2010; Young, Rutherford and Niedfeldt, 2001).

On examination the point of maximal tenderness is located at the anterior medial portion of the calcaneus (Young, Rutherford, Niedfeldt, 2001). Walking barefoot, on toes, or up stairs may exacerbate the pain (Cole, Seto and Gazewood, 2005) which can also be aggravated by passive dorsiflexion of the toes or by having the patient stand on the tips of the toes (Young, Rutherford and Niedfeldt, 2001). PF has also been shown to limit range of motion in the big toe and ankle dorsiflexion (Lillegard and Rucker 1993). The patient may start bearing weight only on the lateral aspect of the affected foot or start limping with the affected heel off the ground and can even have pain at rest if the condition becomes very severe (Cole, Seto and Gazewood, 2005; Reid, 1992). Diagnostic imaging techniques are rarely indicated initially but may confirm or refute a diagnosis of PF (Barret and O'Malley, 1999) and in some cases may help to rule out other causes of heel pain (Roxas, 2005).

2.6.1 Ultrasonography (US)

Ultrasonography is the most widely used imaging modality in podiatric practice to evaluate plantar fascia pathology (Mahowald, Legge and Grady, 2011). It is a very valuable diagnostic tool for detecting plantar fascia thickness as well as documenting inflammatory findings (Karabay, Toros and Hurel, 2007). In patients with PF US may detect relatively small differences in plantar fascia thickness even in clinically undetected cases (Karabay, Toros and Hurel, 2007). The thickening of the plantar fascia as well as hypoechoic changes within the fascia, when viewed under US, have been described by several authors as characteristic features of PF (Fabrikant and Soon Park, 2011; Karabay, Toros and Hurel, 2007 Kamel and Kotob, 2000; Tsai et al., 2000). US has a greater spatial resolution for superficial structures providing an advantage over MRI (Karabay, Toros and Hurel 2007). It has been found to be the most effective imaging tool in the diagnosis of PF (Fabrikant and Soon Park, 2011; Karabay, Toros and Hurel, 2007). It has many benefits as it is quick and easy to perform, non-invasive, cost effective, radiation free and allows perfect resolution for superficial structures (Fabrikant and Soon Park, 2011; Karabay, Toros and Hurel, 2007; Genc et al., 2005). US is also used as a useful objective tool to monitor treatment, as plantar fascia thickness diminishes with successful treatment (Fabrikant and Soon Park, 2011).

2.6.2 Other imaging techniques

Other diagnostic imaging techniques may also be used. These are less specific than the US but can still rule out other causes of plantar heel pain. Plain radiographs can rule out both stress fracture and spondyloarthropathies (Roxas, 2005). They may also pick up calcaneal heel spurs (Menz et al., 2008).

The presence of calcaneal heel spurs is a long-standing source of controversy in both the diagnosis and treatment of PF (Lee and Maurus, 2007). Most authors agree that the presence or absence of heel spurs is not helpful in diagnosing PF (Guijosa et al., 2007; Cole, Seto and

Gazewood, 2005; Aldrige, 2004; Young, Rutherford and Niedfeldt, 2001; Batt and Tanji, 1995). Up to 50% of patients with PF have heel spurs according to Cole, Seto and Gazewood (2005) but many symptomatic PF suffers do not have them and they appear to be relatively common findings with 15-25% of asymptomatic general population having heel spurs (Young, Rutherford and Niedfeldt, 2001). It is interesting to note that calcaneal spurs are more common in the same subgroups as PF, including older people, females and individuals with osteoarthritis (Menz et al., 2008).

Bone scans and magnetic resonance imaging (MRI) are also useful in visualising morphological changes in the plantar fascia but are not often used unless other problems are suspected (Guijosa et al., 2007; Roxas, 2005).

There are a number of other conditions that cause heel pain; most of these can be distinguished from plantar fasciitis by a patient history and physical examination (Cole, Seto and Gazewood, 2005). The most common differential diagnoses of PF are discussed in the next section.

2.7 Differential diagnosis

As with any other injury making an accurate diagnosis is important. This is highlighted when one considers some of the more serious systemic diseases and tumors that can present as a simple overuse injury like PF.

The most common conditions that may cause heel pain and therefore must be differentiated from PF can be broken into categories which according to Young, Rutherford and Niedfeldt (2001) are: soft tissue conditions, skeletal conditions, neurological conditions. Systemic conditions also need to be differentiated (Ambrosius and Kondracki, 1992).

2.7.1 Soft tissue conditions

2.7.1.1 Rupture of the PF

Although uncommon, rupture of the plantar fascia should be suspected with an acute onset of severe plantar heel or arch pain (Alghadir, 2006; Aldridge, 2004; Batt and Tanji, 1995). Such symptoms usually follow intense athletic activity or trauma (Aldridge, 2004; Barret and O’Malley,

1999) and may be associated with prior steroid injections into the plantar fascia (Batt and Tanji, 1995). Pain is described as sudden and ‘knife like’ and may be accompanied by a popping sound (Young, Rutherford and Niedfeldt, 2001). Physical findings suggestive of rupture include a palpable defect in the plantar fascia where it has ruptured, maximal tenderness located distal to the medial process of the calcaneal tuberosity (Barrett and O’Malley, 1999) and visible ecchymosis and swelling in the medial arch of the foot (Young, Rutherford and Niedfeldt, 2001; Batt and Tanji, 1995). The diagnosis can be confirmed using ultrasonography or an MRI (Young, Rutherford and Niedfeldt, 2001).

2.7.1.2 Fat Pad Syndrome/Atrophy/ Heel Pad Disorders

The heel pad is composed of elastic adipose tissue and is located directly beneath the calcaneus acting as a shock absorbing layer protecting the underlying nerves and vessels (Moore and Dalley, 2004). Damage and degeneration of the heel pad, leading to atrophy and pain, can be caused by increased body weight, ageing, poor shoes, walking on hard surfaces (Alshami, Souvlis and Coppieters 2008; Young, Rutherford and Niedfeldt, 2001), and in younger more athletic individuals may result from sports injuries (Aldridge, 2004; Reid, 1992).

Although similar there are noticeable differences between the symptoms of PF and heel pad pain. Heel pad pain is typically more diffuse, involving the weight-bearing central portion of the calcaneus (Alghadir, 2006) unlike PF which usually affects the ant-medial portion of the calcaneus. It does not tend to radiate anteriorly and is not increased by the dorsiflexion of the toes, unlike PF (Aldridge, 2004; Brown, 1996). The plantar fascia is also not tender to touch (Pfeffer and Baxter, 1991). It is comparable to PF patients as both tend to experience pain first thing in the morning; however, unlike PF the pain worsens with activity where in PF pain usually lessens with further activity (Brown, 1996).

2.7.1.3 Bursitis

Bursa’s located in the heel can cause pain if they become irritated and inflamed. The retrocalcaneal bursa, situated between the calcaneus and the insertion of the Achilles tendon, and the retroachilles bursa, lying between the Achilles tendon and the skin, can both become inflamed and present as pain, swelling and erythema of the posterior heel (Young, Rutherford and Niedfeldt, 2001; Pollard and So, 1999). However it is the subcalcaneal bursa that causes pain and tenderness in the central plantar and posterior part of the heel that may mimic the pain of PF (Alghadir, 2006; Bartold, 2003). Radiographically, patients might have visible erosions on the plantar surface of the calcaneus due to subcalcaneal bursitis (Alghadir 2006).

2.7.1.4 Tendonitis

Tendonitis might also mimic the pain of PF (Toomey 2009; Aldrige 2004). Patients with a tendonitis present with pain and possible swelling at the tendon insertion site. Toomey (2009) and Aldridge (2004) agree that inflamed tendons of the posterior tibialis, flexor digitorum longus and flexor hallicus longus, all passing through the medial flexor retinaculum to insert on the medial aspect of the midfoot, may cause mid foot pain similar to that of PF. Achilles tendonitis, resulting from overuse of the calf muscles, may also present with heel pain though more posteriorly located at its insertion onto the calcaneus (Aldridge, 2004). Intrinsic foot muscles like the abductor hallucus, abductor digiti minimi and flexor digitorum brevis all have attachments to the calcaneus and if these attachment sites become inflamed may cause plantar heel pain (Travell and Simons, 1997). Tendonitis pain is characteristic in that it increases with resisted motions (Young, Rutherford and Niedfeldt, 2001). Passive dorsiflexion of the foot and palpation of the tendon insertion site may also increase the tenderness in patients with tendonitis (Aldridge, 2004).

2.7.1.5 Myofascial Trigger Points (MFTPs)

A myofascial trigger point (MFTP) is defined as a focus of hyperirritability found within a taut band of skeletal muscle or its fascia that can cause local and referred pain (Travell and Simons, 1999).

The muscles most likely to be involved in causing pain and other symptoms similar to that of PF according to Travell and Simons (1999) are the intrinsic flexors of the toes, the gastrocnemius, and the soleus. The area of heel pain and tenderness of PF partly matches the MFTP referred pain pattern of the soleus, quadrates plantae and abductor hallucis and MFTP in the flexor digitorum longus muscle can cause pain and tenderness along the distribution of the plantar fascia (Travell and Simons, 1999).

MFTPs located in the intrinsic foot muscles such as the abductor hallucis or quadratus plantae muscles can cause pain similar to that experienced by patients with PF due to the nature of the referral pain patterns. The abductor hallucis refers pain along the medial heel spilling over onto the instep of the sole and the back of the heel. Quadratus plantae refers pain locally to the plantar surface of the heel. Passive extension of the great toe causes pain if there are trigger points in the abductor hallucis, similar to PF where great toe extension also causes pain (Travell and Simons, 1999). Other symptoms of MFTPs in the intrinsic foot muscles include sore feet, pain on walking and, if severe, a deep aching pain at rest (Travell and Simons, 1999) – very similar to PF.

2.7.2 Skeletal conditions

2.7.2.1 Calcaneal stress fracture

The calcaneus is the second most common location for a stress fracture in the foot (Aldridge, 2004). Many authors agree a stress fracture of the calcaneus to be an important differential for PF (Toomey, 2009; Alghadir, 2006; Aldridge, 2004; Bartold, 2003; Barrett and O'Malley, 1999; Batt and Tanji, 1995). Calcaneal stress fractures often present with a history of sudden increase in physical activity (Barrett and O'Malley, 1999). They are most likely to occur in athletes involved in running or jumping sports or in individuals with calcaneal osteopenia (Aldridge, 2004). Similar to PF patients present with diffuse heel pain, often difficult to localise, and tenderness on medial and lateral compression of the calcaneus, the 'squeeze test' (Toomey, 2009; Alghadir, 2006; Aldridge, 2004; Barrett and O'Malley, 1999). Pain patterns are also similar to PF with pain aggravated by prolonged weight-bearing (Young, Rutherford and Niedfeldt, 2001) and increases with exercise (Batt and Tanji, 1995).

Pathologic fractures develop in instances where the calcaneus is weakened possibly by simple bone cysts, Ewing's sarcoma (most common primary bone tumor of the heel), and metastatic tumors to the calcaneus (endometrial adenocarcinoma, bronchogenic carcinoma, transitional cell bladder carcinoma and gastric carcinoma) (Aldridge, 2004). Such tumors can be ruled out using a radiograph (Alghadir, 2006; Aldridge, 2004).

Signs of a stress fracture take time, often weeks, to develop and become visible radiographically (Reid, 1992). Although a diagnosis may be confirmed with a plain-film radiograph, radionuclide bone scans and magnetic resonance imaging (MRI) are considered more effective when diagnosing a stress fracture (Toomey, 2009). Radionuclide bone scans and MRI are more commonly used to confirm a stress fracture as they can detect the subtle signs weeks earlier than a plain radiograph would and also allow the visualisation of adjacent soft tissue structures (Aldridge, 2004; Noakes, 1985).

2.7.2.2 Sever's disease (Calcaneus apophysitis)

Sever's disease, also known as calcaneal apophysitis, is defined by Steadman's Medical Dictionary for the Health Professions and Nursing (2005) as osteochondrosis of the heel, secondary to microfractures in the bone where the Achilles attaches to the posterior calcaneus; an overuse injury and common cause of heel pain in older children. It is caused by increased shearing stress by the gastrocnemius muscle pulling on the posterior calcaneus causing a traction apophysitis to develop (Doxey, 1987).

The patient, most commonly an overweight or very active adolescent, complains of pain with possible swelling over the posterior calcaneus, worse following activity (Doxey, 1987). On examination the main diagnostic finding is pain on medial-lateral compression of the calcaneus in the area of the growth plate (Scharfbillig, Jones and Scutter, 2008; Doxey, 1987) and tenderness on palpation of the posterior calcaneus near the Achilles tendon insertion (Barret and O'Malley, 1999). Normal radiographs demonstrate the characteristic fragmentation, separation and altered density of the calcaneal apophysis and once the symptoms have subsided the apophysis will demonstrate an irregular apophyseal line (Scharfbillig, Jones and Scutter, 2008; Doxey, 1987).

2.7.2.3 Nutritional osteomalacia

Nutritional osteomalacia results from a Vitamin D deficiency and predisposes to PF as it causes softening of the calcaneus and weakening of the intrinsic foot muscles resulting in increased strain on the plantar fascia and can thus be considered both a differential diagnosis and an aetiological factor (Ambrosius and Kondracki, 1992).

2.7.3 Neurologic conditions

2.7.3.1 Tarsal tunnel syndrome

Tarsal tunnel syndrome is a compressive neuropathy of the posterior tibial nerve as it runs through the tarsal tunnel and may cause symptoms that very closely mimic PF (Noakes, 1985). The tarsal tunnel is a fibro-osseous structure on the medial aspect of the ankle bounded medially by the flexor retinaculum and deltoid ligament and laterally by the talus and calcaneus (Magee, 2006; Barett and O'Malley, 1999). Running through this anatomical tunnel are tendons, vessels and the posterior tibial nerve and its terminal branches (Moore, 2004; Noakes, 1985). Compression of the nerve in the tunnel is commonly caused by inflamed tendons within the tunnel; callus formation from previous medial malleolar fracture; increased tension on the posterior tibial nerve due to excessive foot pronation; anatomic variations; pregnancy; trauma and tumors (Barret and O'Malley, 1999; Noakes, 1985).

Patients complain of diffuse pain on the sole of the foot radiating towards the toes (Aldridge, 2004) often accompanied by numbness and/or tingling on the plantar surface of the foot that may progress to be burning in nature (Batt and Tanji, 1995). There is nocturnal pain (Alghadir, 2006; Aldridge, 2004, Barret and O'Malley, 1999) with pain aggravated by exercise which may persist at rest (Batt and Tanji, 1995). On examination the pain can be reproduced by simultaneous dorsiflexion and eversion of the foot, as this stretches and compresses the posterior tibial nerve (Aldridge, 2004). Percussion of the tarsal tunnel, called Tinel's Test, may be positive and cause a tingling sensation along the area of distribution of the posterior tibial nerve (Toomey, 2009; Magee, 2006). Nerve conduction tests and electromyography can be used to confirm this condition (Toomey, 2009; Aldridge, 2004) along with an MRI which can detect the borders of the tarsal tunnel and any soft tissue structures that may be causing compression within it.

2.7.3.2 Tibial nerve compression

Depending on where the nerve is compressed, compression of the tibial nerve can cause symptoms similar to those of PF. The branches of the tibial nerve most likely to be compressed are the medial plantar nerve, the lateral plantar nerve and the nerve to the abductor digiti quinti which is a branch of the lateral plantar nerve. These are discussed in more detail below.

2.7.3.2.1 Medial plantar nerve entrapment

The medial plantar nerve is a terminal branch of the posterior tibial nerve. It may become compressed either as it passes deep to the flexor retinaculum or as it curves deep to the abductor hallucus muscle (Moore 2004). Due to its dermatomal innervations it can cause symptoms similar to those of PF (Noakes, 1985). Symptoms include aching foot arch pain, burning pain in the heel and altered sensation/tingling in the sole of the foot behind the hallux (Magee, 2006). It is associated with a hindfoot valgus and may be referred to as 'jogger's foot' (Magee, 2006; Moore, 2004).

2.7.3.2.2 Lateral plantar nerve entrapment

One of the terminal branches of the posterior tibial nerve (Moore, 2004) can be compressed between the abductor hallicus and the quadrates plantae muscles resulting in a burning sensation on the plantar surface of the heel (Magee, 2006; Young, Rutherford and Niedfeldt, 2001) and in some instances by the medial aspect of the sole (Barret and O'Malley, 1999; Pollard and So, 1999). This pain is different to PF as it is more medial than the calcaneal tubercle, the anterior calcaneal tubercle being the most common site for PF pain (Young, Rutherford and Niedfeldt, 2001). The pain is aggravated by walking, running and excessive foot pronation (Magee, 2006).

2.7.3.2.3 Nerve to the abductor digiti quinti entrapment

The nerve to abductor digiti quinti is the first branch of the lateral plantar nerve and innervates the abductor digiti minimi muscle in the foot. (Moore, 2004). This nerve runs deep to the plantar fascia and when entrapped causes pain almost indistinguishable from PF (Noakes, 1985). Its diagnosis is helped with a good patient history reporting burning pain in the sole of the foot, worse at night and by nerve conduction tests and a positive Tinel's test (Alghadir, 2006).

According to Brantingham et al (1992) nerve entrapment syndromes can be differentiated from PF by a number of features:

- Their lack of localised tenderness over the plantar fascia.
- Neurologic pain is described as burning, sharp shooting, electric and there may possibly be numbness or tingling.

- Pain is worse at night.
- Pain is worse following activity and rest may/may not relieve it.
- Presence of a positive Tinel's sign (tapping over affected nerve causes tingling or shooting pain).
- Definitively diagnosed with nerve conduction tests.

2.7.3.4 L5/S1 nerve root entrapment/sciatica

Nerve root entrapment at the L5/S1 level results in characteristic 'sciatica' type symptoms which constitute pain in the lower back with radiation down the posterior buttock, posterior thigh, posterior calf and lateral foot (Moore, 2004; Barret and O'Malley, 1999). This is usually due to a herniated lumbar disc comprising the L5 or S1 root. The herniation of the L5/S1 lumbar intervertebral disc causes encroachment onto the nerve root compressing it causing the presenting symptoms. On examination orthopaedic tests that place tension on the sciatic nerve, such as the straight-leg raise, will be painful and can help in the diagnosis of a herniated disc (Magee 2006). There may be muscle weakness in the hamstring and gastrocnemius muscles as well as a reduced plantar response i.e. the deep tendon reflex of the Achilles (Magee, 2006). The diagnosis can be confirmed with diagnostic imaging such as MRI or CT and less commonly with plain film lumbar radiographs (Magee, 2006; Barrett and O'Malley, 1999). Images may show lumbar disc herniation, other disc pathology, and stenosis of the intervertebral foramina or central canal (Barrett and O'Malley, 1999).

2.7.3.5 Peripheral neuropathy

A peripheral neuropathy is a disorder that affects one or more peripheral nerves (Boon, Colledge and Walker, 2006). Should the posterior tibial nerve or one of its terminal branches be affected symptoms similar to that of PF may be experienced (Toomey, 2009). A peripheral neuropathy may develop due to drugs, diabetes mellitus, alcoholism, vitamin deficiencies (Vitamin B, Folic acid, Vitamin E), certain neoplasms (myeloma and lymphoma) and some immune-mediated diseases like systemic lupus erythramatosus and rheumatoid arthritis (Boon, Colledge and Walker, 2006).

2.7.3.6 Neuroma

A neuroma is a neoplasm derived from cells of the nervous system (Stedman, 2005). A neuroma of the medial calcaneal nerve, although uncommon, can cause heel pain that might present with symptoms very similar to those of PF (Aldridge, 2006). On palpation of the sole of the foot in patients with a medial calcaneal nerve neuroma, a painful lump may be felt near the heel or proximal midfoot, this lump is called the 'lamp cord sign' as it feels like a lamp cord under a rug (Aldridge, 2006). This lump indicating the neuroma should not be confused with an inflamed or ruptured plantar fascia (Barrett and O'Malley, 1999).

2.7.4 Systemic conditions

A variety of systemic disorders can present with heel or foot pain, these conditions while co-existing with PF can also cause it and should also be considered aetiological factors (Ambrosius and Kondracki, 1992). Some examples of these conditions include, but are not limited to: rheumatoid arthritis, gout, the sero-negative spondyloarthropathies (ankylosing spondylitis, Reiter's syndrome, psoriatic arthritis and inflammatory bowel disease-associated arthritis), Bechet's syndrome, systemic lupus erythematosus (Aldridge, 2004; Bartold, 2003; Barrett and O'Malley, 1999; Batt and Tanji, 1995) gonorrhea and tuberculosis (Barrett and O'Malley, 1999).

Most patients with a systemic disease will present with joint pain and inflammation in other areas of the body; however symptoms can present initially as pain in the heel (Barrett and O'Malley, 1999). PF resulting from a systemic disorder is usually bilateral (Barrett and O'Malley, 1999; Hammer, 1991) and may or may not be associated with joint pain or inflammation in other areas (Batt and Tanji, 1995; Ambrosius and Kondracki, 1992).

Aldridge (2004) and O'Malley (1999) both emphasise the importance of a proper detailed patient history and thorough physical examination which will usually reveal symptoms and signs of a systemic disease. These can then be diagnosed or ruled out by the appropriate diagnostic imaging tests (plain radiographs, MRI's, bone scans or CT's) or laboratory tests such as blood tests (uric acid levels, rheumatoid factor, genetic markers etc.) (Barrett and O'Malley, 1999; Anbrosius and Kondracki, 1992).

2.8 Treatment

PF is known to be a frustrating and notoriously difficult condition to treat (Roxas, 2005; Bartold, 2003) with recovery time varying from months to years (Cole et al 2005) but usually stated as being between 6 and 18 months (Young, Rutherford and Niedfeldt, 2001) although it can persist for as long as 24 months (Murtagh, 2003).

2.8.1 Conservative treatment

According to Steadman's Medical Dictionary for the Health Professions and Nursing (2005) conservative treatment denotes treatment by gradual, limited or well-established procedures as opposed to radical interventions. Hyde and Gengenbach (2007) state that conservative management for injuries is management that seeks to avoid the pain, cost, time loss and risk associated with surgical intervention.

Most authors agree that conservative treatment is the recommended initial treatment for PF (Young, 2012; Roxas, 2005; Bartold, 2003; Ambrosius and Kondracki, 1992; Batt and Tanji, 1995; Noakes, 1985) with well over 90% of patients experiencing full resolution of symptoms or reaching tolerable levels of pain and minimal activity limitation with the implementation of time and a good conservative treatment plan (Toomey, 2009).

2.8.2 Advice and the correction of environmental factors

Advice and patient education is important as this may help eradicate possible aggravating factors of PF. Advice can be provided on weight loss, rest from activities, training error correction, changing of footwear, recommended changes in daily activities and home therapies that can offer some relief (Barrett and O'Malley, 1999). In athletes the training techniques should be reviewed and potential contributing factors like hill running, stair climbing, sudden increases or changes in training should be addressed (Bartold, 2003). Other advice for runners, as suggested by Barrett and O'Malley (1999), include reducing mileage, changing the running surface and stretching.

Rajiput and Abboud (2004) and Young, Rutherford and Niedfeldt (2001) both advocate the use of proper footwear with adequate support with Batt and Tanji (1995) further emphasising appropriate footwear use for both sport and everyday activities as obvious and often missed suggestions for correcting inciting factors of PF. Unsuitable footwear can greatly affect the efficacy of treatment and may prolong PF (Rajiput and Abboud, 2004). Shoe construction and wear need to be examined to ensure proper support is given to the foot as with time there is degradation of the shoe and an increased incidence of injury (Rajiput and Abboud, 2004). Shoes should fit properly and offer support. Running shoes tend to lose their shock absorbing capacity with use and may need to be replaced to relieve symptoms of PF (Batt and Tanji, 1995; Reid, 1992).

2.8.3 Rest

Reid (1992) states that rest is the key to effective treatment with many other authors in agreement (Young, Rutherford and Niedfeldt, 2001; Noakes, 1985). Rest is a very important aspect in the initial approach treating PF, especially in cases where the cause is overuse (Young, Rutherford and Niedfeldt, 2001; Barret and O'Malley, 1999; Naokes, 1985). Resting involves avoidance of aggravating activities such as running, long walks and prolonged weight-bearing; eliminating them completely or via substitution with non-weight-bearing activities like cycling and swimming (Young, Rutherford and Niedfeldt, 2001; Batt and Tanji, 1995). Rest decreases tensile forces that act on the plantar fascia when active, allowing healing to occur. In athletes and individuals whose occupation does not allow complete rest 'relative rest' is used, where intensity or duration of activities are reduced or alternate forms of activities are used in place of those that aggravate the symptoms of PF (Young, Rutherford and Niedfeldt, 2001; Batt and Tanji, 1995).

2.8.4 Stretching and strengthening

Stretching and strengthening programs correct functional risk factors such as tightness of the triceps surae complex and weakness of the intrinsic foot muscles (Young, Rutherford and Niedfeldt, 2001). Stretching of tight muscles in and around the foot is considered an effective treatment of PF by many authors (Toomey, 2009; Barrett and O'Malley, 1999; Batt and Tanji, 1995; Noakes, 1985) with Bartold (2003) stating that stretching is arguably the single most important component of treatment for PF. Specific stretching should be to the gastrocnemius, soleus and hamstring muscles and to the plantar fascia itself (Bartold, 2003). According to Young, Rutherford and Niedfeldt (2001) increasing flexibility of the gastrocnemius and soleus muscles are particularly important and commonly used stretches to do this are leaning wall stretches and stair stretches. Rolling the foot over a tennis ball can be used for the plantar fascia itself (Roxas, 2005), alternatively rolling the foot over an ice filled bottle (Bartold, 2003). In studies by Wolgin et al. (1994) and Davies, Severund and Baxter (1994) stretching of the Achilles tendon was found to be the most effective form of treatment helping 25-29% of patients respectively. Strengthening exercises focus on the intrinsic foot muscles and include exercises like towel curls, toe taps and picking up marbles with the toes (Roxas 2005; Young, Rutherford and Niedfeldt, 2001).

2.8.5 Night splints

Night splints are a common and effective form of treatment for PF (Gotlin, 2008; Barry, Barry and Chen, 2002; Barret and O'Malley, 1999; Ryan, 1995) and are designed to keep the patients ankle in a neutral position overnight allowing the passive stretching of the calf and plantar fascia during sleep. This prevents contracture and allows healing of the fascia in the elongated position (Roxas, 2005; Young, Rutherford and Niedfeldt, 2001). Most individuals sleep with their feet plantar-flexed naturally; this position causes shortening of the plantar fascia (Young, Rutherford and Niedfeldt, 2001). Night splints resist secondary night-time contraction of the gastrocnemius and soleus muscles and intrinsic foot musculature, as well as resisting gravitational forces that cause shortening of the plantar fascia (Barry, Barry and Chen, 2002). The use of night splints follows on from stretching as the theory is to prevent shortening of the plantar fascia during long periods of rest preventing the initial excessive stretch placed on the plantar fascia upon rising (Toomey, 2009). Clinical studies on night splinting have yielded mixed results (Roxas, 2005).

Morning pain due to contracture, a common symptom of PF, is significantly reduced by splint use (Young, Rutherford and Niedfeldt, 2001; Batt and Tanji, 1995; Ryan, 1995). The patient is gradually weaned off the splint as symptoms are reduced (Batt and Tanji, 1995). The splint is typically well tolerated and may be used in conjunction with other conservative modalities (Batt and Tanji, 1995). Splints are generally moulded from plaster or fiberglass casting material however prefabricated plastic commercial braces are also available (Young, Rutherford and Niedfeldt, 2001). Disadvantages of night splints are mild discomfort that can interfere with the patient or bed partner's ability to sleep (Young, Rutherford and Niedfeldt, 2001).

2.8.6 Orthotics

Orthotics are used to reduce tissue stress (Bartold, 2003) and provide relief by reducing tension on the plantar fascia, correct biomechanical factors that contribute toward developing PF, aid in shock absorption (Young, Rutherford and Niedfeldt, 2001; Barrett and O'Malley, 1999) and limit pronation thus reducing overstretching of the plantar fascia (Batt and Tanji, 1995). Many different types of orthoses are available including over-the-counter arch supports, custom made orthotics and heel cups (Young, Rutherford and Niedfeldt, 2001).

Over-the-counter arch supports are useful in patients with acute PF although the support offered by these is variable depending on the material they are constructed from (Young, Rutherford and Niedfeldt, 2001). Various rigid, semi-rigid and soft arch supports are available commercially (Alghadir, 2006). Generally patients are advised to find the densest material that is still soft enough to be able to comfortably walk on (Alghadir, 2006; Young, Rutherford and Niedfeldt, 2001).

Custom orthotics are made after taking an impression of the individual's foot and constructing an insert specifically designed to control biomechanical risk factors (pes planus and leg length discrepancies). The most common prescription for patients with PF is a semi-rigid, three-quarter to full-length orthotic with longitudinal arch support (Young, Rutherford and Niedfeldt, 2001).

Heel cups, also known as heel pads or heel cushions, are more commonly used in patients with fat pad syndrome or a heel bruise (Young, Rutherford and Niedfeldt, 2001). They decrease impact on the calcaneus and plantar fascia by elevating the heel onto a soft cushion which assists weight redistribution while also slightly reducing the pull of the Achilles tendon as it is placed into a slightly shorter position; these factors help provide symptomatic relief (Murtagh, 2003; Batt and Tanji, 1995). Young, Rutherford and Niedfeldt (2001) state the main disadvantage of orthotics is their cost which ranges depending on the type bought.

2.8.7 Cryotherapy (ice therapy)

Cryotherapy is the use of cold in the treatment of an injury (Stedman, 2005). Ice is a commonly used anti-inflammatory agent that is useful in addressing the inflammation caused by PF especially during the acute stage (Batt and Tanji, 1995). It diminishes the inflammatory reaction, reduces oedema, minimises hemorrhage and has an analgesic function (Barrett and O'Malley, 1999). Cryotherapy for PF can be applied in the form of an ice massage, ice bath or ice pack that is usually applied for 10-20 minutes to the plantar surface of the heel and is usually done after periods of exercise, stretching, strengthening or daily in the evening after a day of work (Young, Rutherford and Niedfeldt, 2001).

2.8.8 Manual therapy

2.8.8.1 Transverse frictions

Transverse frictions are of proven clinical value in the treatment of subacute and chronic injuries and are commonly used to treat PF (Maartens, 2005; Dunn, 2005). Transverse frictions promote a traumatic hyperemia and reduce oedema in chronically inflamed tissue; they free adhesions (scar tissue) and eventually help induce a controlled inflammation for a more structured recovery and progression to later stages of healing (Cyriax, 1984). In PF treatment they are used to break down and reduce fibrotic scar tissue within the plantar fascia and help control inflammation (Brantingham et al., 1992). They can also be effective in improving flexibility by breaking down adhesions, help with the modulation of pain and in the stimulation of healing ensuring soft-tissue repair is as strong as possible (Bird, Black and Newton, 1997).

2.8.8.2 Graston Technique Instrument-Assisted Soft Tissue Mobilisation (GISTM)

GISTM is a specific soft tissue technique that utilises six concave/convex stainless steel instruments called Graston tools. These have double-beveled edges to treat a variety of soft tissue conditions (Hammer, 2001). Graston tools are used to apply a cross friction type massage using a variety of multidirectional stroke techniques over the affected area of scar tissue resulting in controlled amounts of microtrauma at the affected site causing small amounts of inflammation that helps to remodel the structure of the tissue, remove fibrosis, realign the collagen and help restore function (Falvey, 2004; Hammer, 2001). In this sense GISTM is based on the principles of transverse frictions (Maartens, 2005). In patients with PF the technique can be applied directly to the fascia and also to areas of involvement proximal and distal to the lesion, such as a tight Achilles tendon, for best results (Hammer, 2003). Research has shown

Graston Technique to be useful and it is indicated in the treatment of PF (Dubin, 2007; Maartens, 2005).

2.8.8.3 Laser

Laser has shown to be as effective as placebo in the treatment of PF, with little evidence to support it being beneficial and is thus not advised as a treatment for PF (Guijosa et al., 2007; Basford et al., 1998).

2.8.8.4 Therapeutic ultrasound

Ultrasound is said to reduce inflammation and enhance healing and numerous authors have advocated it as a useful treatment modality for PF (Dubin, 2007; Du Plessis, 2002; Batt and Tanji, 1995). However there is conflicting evidence in its efficacy as an evidence based treatment for PF (Guijosa et al., 2007; Zanon, Brasil and Imamura, 2006; Atkins, Crawford and Lambert, 1999; Crawford and Snaith, 1996). A study by Crawford and Snaith (1996) has shown that it is only as effective as placebo in the treatment of PF whilst a later study by Zanon, Brasil and Imamura (2006) showed that local application of US did not add value to functionality or provide pain relief in chronic PF cases.

2.8.8.5 Acupuncture

Acupuncture is an ancient Asian system of healing that uses long fine needles that are inserted into acupuncture points on the body surface which are believed to correct disturbances of energy flow associated with disease (Steadman's Medical Dictionary for Health Professions and Nursing, 2005). It has been proposed as an effective treatment for PF however most reports have been anecdotal in nature (Roxas, 2005; Bartold, 2003). A small study by Perez-Milan and Foster (2001) showed favourable results when acupuncture was used in conjunction with electrical stimulation in the treatment of PF. In another study the use of electro-acupuncture in combination with conservative therapies resulted in reduction in pain and foot plantar pressure in patients with PF (Ebrahim et al., 2007).

2.8.8.6 Dry needling

An alternative treatment for PF using needles is that of trigger point dry needling. Dry needling is commonly used for the treatment of many musculoskeletal conditions (Cotchett et al., 2011; Bartold, 2003) involving the stimulation of MFTPs using a fine filament needle (Cotchett et al., 2011). MFTPs as defined by Travell and Simons (1999) are areas of hyperirritability within a muscle or its fascia that cause local and referred patterns of pain. Travell and Simons (1999) emphasise the importance of checking for MFTPs in muscles with referral pain patterns similar to that of PF, these include: gastrocnemius, soleus, quadrates plantae and abductor hallucis. Perez-Milan and Foster (2001) reported favorable results and a significant reduction in pain treating PF with a combination of acupuncture and dry needling of the heel and arch; however, there are very few studies showing its effectiveness in the treatment of PF (Atkins, Crawford and Lambert, 1999).

2.8.8.7 Manipulation

As many as 95.4% of Chiropractors manipulate extremities (Hoskins et al 2006). Chiropractic manipulation delivered to the bones and joints of the foot may be used to restore normal alignment, biomechanics and joint mechanics within the foot to promote correct functioning and decrease tension across the plantar fascia (Hyde and Gengenbach, 2007). Barrett and O'Malley (1999) agree that in patients with PF a complete biomechanical evaluation of the foot should be done including checking range of motion of the first metatarsophalangeal, midtarsal, subtalar and ankle joints. Manual adjustments to the ankle and foot help free up joint motion of the talocrural, subtalar and midtarsal joint articulations (Dubin, 2007). Correction of abnormal biomechanics is essential in the treatment of PF (Barrett and O'Malley, 1999; Noakes, 1985). Various authors have found manipulation alone, or in combination with other forms of therapy, to be an effective form of treatment of PF (Blake, 2003; Du Plessis, 2002; Morris, 2000; Brantingham et al., 1992).

2.8.9 Drugs/Medication

2.8.9.1 Over the counter (OTC) medications

OTC medications like painkillers, anti-inflammatories and various other drugs may be used to treat PF. These simply reduce or eliminate the pain temporarily by masking the symptoms and do not address the underlying condition. These drugs also have side effects and may be addictive.

2.8.9.2 Anti-inflammatories

Oral non-steroidal anti-inflammatory drugs (NSAID's) such as Ibuprefen and Diclofenac, can be used in the treatment of PF as they are effective in treating pain and stiffness of inflammatory origin and if given at night are helpful in markedly reducing inflammatory morning stiffness (Boon, Colledge and Walker, 2006). However their primary use is to reduce and control inflammation; they do not address the underlying problem causing the PF (Young, Rutherford and Niedfeldt, 2001). Advantages of NSAID's include convenience of use and ease of administration (Young et al 2001).

There are many potential side effects associated with the use of NSAID's including gastric ulceration and bleeding, increased fluid retention, abdominal pain, altered bowel habits, rashes, asthma, anaphylaxis and on the rare occasion interstitial nephritis (Boon, Colledge and Walker, 2006). The risk for side effects increases in patients over 60, high dose or multiple NSAID's use and in patients with a past history of peptic ulcers (Boon, Colledge and Walker, 2006).

2.8.9.3 Corticosteroids

Corticosteroid injections are usually reserved for chronic or recalcitrant cases of PF that have failed to be treated successfully with conservative treatment (Batt and Tanji, 1995). Corticosteroid injections provide temporary relief of pain and their use in the treatment of PF is controversial as corticosteroids have been shown to weaken collagen and this may contribute to acute rupture of the plantar fascia and can cause a loss of the plantar fat pad i.e. fat pad atrophy (Young, Rutherford and Niedfeldt, 2001; Barrett and O'Malley, 1999; Batt and Tanji, 1995). Typically a mixture of Lidocaine, Marcaine and Trimcinolone is injected around the medial process of the calcaneal tubercle (Barrett and O'Malley, 1999; Batt and Tanji, 1995). This can be done via a medial or plantar approach under ultrasonography guidance often used to facilitate correct injection placement and avoidance of the fat pad (Young, Rutherford and Niedfeldt, 2001).

2.8.10 Iontophoresis

Iontophoresis is the use of electric impulses from a low-voltage galvanic current stimulation unit to drive topical corticosteroids, usually Dexamethasone, into soft tissue structures (Young, Rutherford and Niedfeldt, 2001). It has been used in the treatment of PF with good results especially in cases where immediate results are needed i.e. active patients and performance athletes (Gudeman et al., 1997). Guijosa et al. (2007) state that there is still limited evidence to support the use of iontophoresis as an effective treatment of PF. Advantages are that iontophoresis is a non-invasive and painless procedure and that local administration of a corticosteroid results in a lower dose than those achieved with an injection but higher than an oral administration (Gudeman et al., 1997). Disadvantages are cost and time as it requires doses two to three times a week, administered by a qualified physical therapist (Young, Rutherford and Niedfeldt, 2001).

2.8.11 Extracorporeal Shock-Wave Therapy (ESWT)

ESWT has been touted as a non-invasive alternative to surgery in cases of chronic, recalcitrant PF and is based on lithotripsy technology that uses pulses of high-pressure sound waves to bombard damaged tissue in the plantar fascia breaking up scar tissue and promoting neovascularisation in the area to help relieve the pain associated with PF (Toomey, 2009; Roxas, 2005). It is non-invasive, has a relatively short recovery time and has a success rate comparable to that of surgery (Roxas, 2005). However it is expensive (Toomey, 2009). Current indications for the use of ESWT, as noted by Toomey (2009) are pain having lasted at least 6 months and recalcitrant to three or more conservative modalities (Toomey, 2009).

2.8.12 Platelet-rich plasma (PRP) injections

PRP uses platelets and plasma from the patient’s own blood which is then injected at the site of injury. In giving a hyperphysiologic dose of platelets, cytokines and the different growth factors released by the platelets it stimulates and accelerates soft tissue healing and regeneration abilities at the site of degeneration or injury be it muscle or tendon (Martinelli et al., 2013). PRP has been used to treat many foot and ankle pathologies, including PF with positive results (Martinelli et al., 2013).

2.8.13 Surgery

Surgery should only be considered for cases of PF that fail to respond to any conservative therapy over a period of several months (Roxas, 2005; Young, Rutherford and Niedfeldt, 2001; Barrett and O'Malley, 1999); often recommended as no less than six months to a year (Toomey, 2009). Young (2012) states that 5% of patients end up undergoing surgery after conservative measures have failed. All surgical procedures entail a partial release of the plantar fascia, known as a fasciotomy, which can be accomplished endoscopically or as open surgery (Toomey, 2009). Nerve decompression and removal of heel spurs can be completed at the same time as the fasciotomy (Roxas, 2005). Recovery from surgery is variable, usually slow, taking several weeks to several months (Roxas, 2005). With endoscopic techniques the recovery is much faster with less chance of side effects (Barrett and O'Malley, 1999). Endoscopic procedures showed less risk of complications with 17% of patients experiencing complications compared to 35% of patients that undergo traditional surgery (Landorf and Menz, 2007). Possible side effects or complications of surgery include infection, flattening of the longitudinal arch, heel hypoesthesia, rupture of the plantar fascia, recurrent pain, neuritis and anesthesia complications (Landorf and Menz, 2007; Young, Rutherford and Niedfeldt, 2001). A postoperative rehab and strengthening program is advised (Batt and Tanji, 1995).

2.9 Low-Dye taping

2.9.1 Introduction

Conservative treatment involving the use of strapping or structural correction is the first line of treatment in PF (Hunt et al., 2004; Rajiput and Abboud, 2004). Bartold (2003) advocates the use of taping techniques for the treatment of PF stating that they are one of the most reliable short-term treatment options. 'Low-Dye' taping is a taping technique that has been routinely used in podiatry and physical therapy since the 1940s (Toomey, 2009; Saxelby, Betts and Bygrave, 1997; Reid, 1992). It was derived from the taping techniques introduced by Dr. Ralph Dye; the tapings he developed that extended up the leg were known as 'High-Dye' whilst those confined to the foot were termed 'Low-Dye' (Saxelby, Betts and Bygrave, 1997). It has been used in the management of an array of foot pathologies, especially plantar fasciitis (Saxelby, Betts and Bygrave, 1997) in relation to sports as well as normal daily activity (Harradine, Herrington and

Wright, 2001). The Low-Dye technique has been used frequently and is documented in the literature as having a beneficial effect in the treatment of PF (Reid, 1992). The introduction of foot orthoses into the podiatry profession saw the usage of taping decrease. However, due to the relative failure of these devices to relieve symptoms in all patients there has been renewed interest in Low-Dye taping as a management tool (Saxelby, Betts and Bygrave, 1997). Taping of the foot using the Low-Dye method has been advocated by many authors and has shown to be beneficial in treating PF with several authors agreeing that Low-Dye arch taping of the foot is effective in the treatment of PF (Bagewadi, Santosh and Ganesh, 2010; Toomey, 2009; Hunt et al., 2004; Saxelby, Betts and Bygrave, 1997; Ryan, 1995; Chandler and Kibler, 1993; Brantingham et al., 1992).

2.9.2 Properties of Low-Dye tape

Low-Dye taping is performed using a rigid strapping tape. This is composed of a non-stretch, rigid tape with a high tensile strength and a zinc oxide adhesive. The tape has serrated edges for easy tear. (Mueller EuroTape, 2014).

2.9.3 Therapeutic effects

Taping with rigid tape, also called 'athletic taping', is commonly used by therapists primarily for the mechanical properties the tape provides that allow it to provide support to the injured structure as well as prevention against re-injury (Reid, 1992). Lesser properties of the tape include proprioceptive feedback as well as controlling swelling and pain, although these effects are minimal (Callaghan, 1997).

In taping the foot for PF Hyde and Gengenbach (2007) state that tape should limit abnormal or excessive motion while supporting the underlying compromised structures. With Low-Dye taping the medial longitudinal arch of the foot is supported during mid-stance of the gait cycle and there is restriction of pronation of the foot. (Ryan, 1995; Brantingham et al., 1992). In the treatment of PF Low-Dye taping is used to biomechanically control tensile forces generated through the plantar fascia (Hunt et al., 2004). This is achieved as immobilisation with Low-Dye taping shortens the distance between origin and insertion of the plantar musculature and fascia (Yale, 1987); this decreases stress and tensile force along the plantar plate protecting the plantar fascia. In this way Low-Dye taping aims to allow healing to occur naturally (Hunt et al., 2004; Ambrosius and Kondracki, 1992).

Low-Dye taping has proven effective for the short-term treatment of the common symptom of 'first-step' pain, the pain experienced when first standing after arising from bed in the morning, in patients with PF (Radford et al., 2006). Hunt et al. (2004) evaluated the effectiveness of arch taping in controlling pain during ambulation and found that taping appeared effective in controlling pain and improving ambulation. A study by Lynch et al. (1998) showed that arch taping and orthotics were significantly better than the use of cortisone injection or heel cups in the treatment of PF.

2.9.4 Contraindications

Tape application should accommodate the underlying anatomy and prevent binding of the skin as this can cause pain, cuts, blisters or bruising (Hyde and Gengenbach, 2007). According to Athletic Taping (1994) there are certain instances when taping is not advised; these include but are not limited to:

- After an acute injury has occurred;
- When further assessment is required for an injury to determine its extent;
- If there is functional disability including reduced range of motion, decreased strength and decreased stability;
- Acute sudden swelling;
- After cold application as the tape may not stick;
- Pre-puberty (age 10-14) as taping can adversely affect the epiphyseal growth plate.

2.10 Kinesio taping

2.10.1 Introduction

Dr Kenzo Kase a Japanese Chiropractor from Tokyo invented Kinesio tape and the Kinesio Taping method in 1973 (Kase, Wallis, and Kase, 2003). After using standard athletic 'white tape' to wrap the swollen joints of a rheumatoid arthritis sufferer, worsening the pain and inflammation due to the pressure of the tape, Kase began to think of alternate ways he could create a negative pressure under the skin allowing inflammation to clear and drain more freely (Taping America's Athletes, 2012). Kase sought a healing technique that the patient could take home with them, be able to use between visits and which would help heal traumatised tissue in the body. In 1979 he officially founded The Kinesio Taping Method helping to develop the tape which was introduced in Japan in the 1980's. It was used by Japanese athletes at the Seoul Olympics in 1988 where it received worldwide exposure and has since become one of the fastest growing and most widely used treatment modalities (Zuidewind, 2011). It is currently used in numerous different sporting codes including, but not limited to, athletics, American football, badminton, cycling, tennis, rugby and football (Van Der Westhuisen, 2012). Away from the sporting ambit it is used by many manual therapists in treating injuries ranging from those of a minor nature to severe and even in post-surgical patients (Kase, Wallis and Kase, 2003).

2.10.2 Properties of Kinesio tape

Kinesio tape is comprised of a polymer elastic strand wrapped by 100% cotton fibers and is latex free. The elastic properties of the tape allow a one-way stretch along the longitudinal axis only and can be stretched 55-60% from resting length. This degree of stretch approximates the elastic qualities of the human skin (Kase, Wallis and Kase, 2003). The tape is not designed to be stretched horizontally.

The cotton fibers allow for quick drying and evaporation of body moisture. The adhesive on the tape is 100% medical grade acrylic and is heat activated becoming more adherent the longer the tape is worn with it being stated that it can be comfortably worn for 3-5 days (Kase, Wallis and Kase, 2003). The adhesive is applied in wave-like patterns mimicking the qualities of finger prints on the fingertip (Kase, Wallis and Kase, 2003). This assists in lifting the skin and also allows for zones in which moisture is able to escape.

The thickness of the tape is approximately the same as that of the epidermis of the skin, intended to limit the body's perception of weight and to help avoid sensory stimuli when properly applied (Kase, Wallis and Kase, 2003). After approximately 10 minutes the patient will generally not perceive there is any tape on their skin.

As tape is applied to the skin, it provides a pulling force to the skin and creates more space by lifting the fascia and soft tissue under the areas where it is applied (Kase, Wallis and Kase, 2003). This assists in lifting the skin while also allowing zones from which moisture can escape (Kase, Wallis and Kase, 2003). Rubbing the tape after application allows the tape to adhere better to the skin.

2.10.3 Therapeutic effects

The proposed mechanisms by which it works is different to that of traditional taping as Kinesio tape is proposed to exert its physiological effects on skin, circulatory and lymphatic system, fascia, muscles and joints (Illes, 2009). Application of Kinesio tape forms convolutions of the skin causing microscopic skin lifting thus promoting lymphatic drainage from the interstitial spaces and consequently alleviating oedema, inflammation and pain (Illes, 2009). The proposed mechanisms of its action as proposed by Kase, Wallis and Kase (2003) include:

- Correcting muscle function by strengthening weakened muscles;
- Improving circulation of blood and lymph by eliminating tissue fluid (oedema) and bleeding beneath the skin therefore decreasing swelling;
- Decreasing pain through neurological suppression;
- Repositioning subluxed joints by relieving abnormal muscle tension, helping to return the function of fascia and muscle to normal.

The Kinesio Taping Method is used by physical and occupational therapists, athletic trainers, chiropractors, acupuncturists, and other health care practitioners around the globe (Kase, Kase and Wallis, 2006). Kinesio tape can be applied in different ways to achieve the desired therapeutic effect. It is therapeutic in nature and allows free movement and does not restrict like conventional athletic taping which is strictly structurally supportive. Due to its beneficial properties it is used in sport injury prevention, rehabilitation of injured athletes and sports performance enhancement (Wong, Cheung and Li, 2012). Tsai, Chang and Lee (2010) showed that taping with Kinesio tape in addition to traditional therapy was more effective in the treatment of plantar fasciitis.

2.10.4 Contraindications

When taping with Kinesio tape one should take note of any contraindications to taping if they are present; these include but are not limited to:

- Open wounds, recently formed scars, recently irradiated skin;

- Over active malignant areas due to the risk of spreading the cancer;
- Skin irritation (redness, rash itchiness, cellulitis or infection);
- Allergies to any adhesives, tape or medical adhesive bandages; if an allergy is suspected (from the case history or if the patient has fragile skin) test a small piece of Kinesio tape by applying it to the skin prior to its therapeautic application to determine the patient's response (Kase, Kase and Wallis, 2003).

2.10.5 Rationale for the use of Kinesio tape for PF

In the treatment of PF Kinesio tape is used to help resolve oedema caused from the inflammatory component of PF. This is achieved by lifting the skin due to the wave-like patterns on the tape itself and secondarily resulting from the specific taping technique for PF that is applied. Reduction of oedema in the area can cause a reduction in pain. Additionally the tape's stimulation of proprioceptive fibers decreases the stimulation of nociceptive nerve fibers decreasing pain perception (Illes, 2009). Kinesio tape can correct muscle function and reduce fatigue of the plantar musculature by normalising the muscle ratio and tension which can stop the progression and development of PF.

2.11 Conclusion

Low-Dye taping involves the use of a non-stretch, rigid tape to biomechanically control tensile forces generated through the plantar fascia (Hunt et al., 2004). Conversely Kinesio tape is an elastic tape that allows a one-way longitudinal stretch (Kase, Wallis and Kase, 2003).

The mechanism of action for Low-Dye taping is achieved due to immobilisation as the taping shortens the distance between origin and insertion of the plantar musculature and fascia (Yale, 1987). The shortening decreases stresses and tensile forces on the plantar fascia allowing healing to occur naturally (Hunt et al., 2004; Ambrosius and Kondracki, 1992). Kinesio tape has a proposed mechanism of action that involves correcting muscle functioning by strengthening weak muscles, resolving oedema and pain due to inflammation, neurologically suppressing pain and relieving muscle tension to return functioning of the fascia and muscle to normal (Kase, Wallis and Kase, 2003).

Low-Dye taping has been proven effective for the short-term treatment of ‘first-step’ pain in patients with PF (Radford et al., 2006). Hunt et al. (2004) found arch taping to be effective in controlling pain and improving ambulation. Kinesio tape has also shown to be effective in the treatment of PF and when added to traditional therapy Tsai, Chang and Lee (2010) showed treatment of PF to be more effective.

Du Plessis (2002) and Brantingham et al. (1992) have stated a need for more research into the treatment of PF, especially in terms of each different modality or treatment used. Bartold (2003) advocates the use of taping techniques to treat PF stating they are amongst the most reliable short-term treatment options. Low-Dye taping and Kinesio taping have different intrinsic tape properties as well as different mechanisms of action in the treatment of PF. No study has been conducted comparing each to the other although both have been proven effective in the treatment of PF. This study aims to compare the two to see whether one outperforms the other in the treatment of PF.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter outlines the general procedure used to carry out this study. It includes the research design, sampling procedure, participant inclusion and exclusion criteria, a description of the interventions received, the types of data collected and the statistical methods used.

3.2 Research design

This study was designed as a prospective randomised clinical control trial, to determine which taping technique, Kinesio taping or Low-Dye taping, was more effective in the treatment of plantar fasciitis. It was given ethical clearance (ethical clearance number – 033/12) (Appendix L) through The Durban University of Technology's Institutional Research Ethics Committee (IREC). This aligns itself with the Declaration of Helsinki, 1975 (Johnson, 2005).

3.3 Sample

A total of 30 participants were recruited from the greater Durban area.

3.4 Participant recruitment

Participants were recruited through convenience sampling by means of advertisements (Appendix A) informing the public of the study being conducted. These were placed around the DUT Chiropractic Day Clinic and areas of communal gathering (local gyms, sports clubs and businesses) within the greater Durban area. Verbal permission was obtained from the managers of the sports clubs/gyms before the advertisements were placed.

3.5 Participant screening

All candidates that responded to the advertisement underwent a cursory telephonic interview with the researcher to determine their eligibility to participate in the study. Table 1 lists the screening questions.

Table 1: Telephonic interview questions

Questions	Required responses
Do you know enough about the study?	Yes
Are you willing to answer some questions over the phone in order to determine your eligibility?	Yes
How old are you?	Between 20 and 45 years
With reference to the pain, where is it located?	Around the heel/arch/sole of the foot
Is the pain aggravated by foot dorsiflexion?	Yes
Is the pain worse on the first few steps in the morning?	Yes
Is the pain made worse by standing or walking on your toes?	Yes
On a scale of one to ten, zero being no pain at all and ten being the worst pain possible, what is the pain in your foot currently?	Four or greater
Do you have a history of foot or ankle: fractures, dislocation, surgery, peripheral neuropathy, nerve root entrapment or any other known condition that might cause foot pain?	No
Do you suffer from any systemic diseases?	No
Have you had any treatment in the last two weeks, or have you been involved with another research study at DUT within the last three months?	No If yes – there is a wash out period of two weeks for treatment and three months for research
Are you willing to partake in this research study free of charge?	Yes

Suitable candidates who met the above criteria were then booked for appointments at the DUT Chiropractic Day Clinic. Each participant received a detailed Letter of Information and Informed Consent form (Appendix B) to read and sign. This explained what the research entailed and what was expected from them as well as their right to freely withdraw from the study at any time. The participant was allowed to ask questions regarding the research which the researcher answered.

The participant was then interviewed (Appendix C) and thereafter an objective examination was conducted consisting of a general physical (Appendix D) and a foot and ankle regional examination (Appendix E). After this it was determined whether they met the inclusion and exclusion criteria of the study.

3.6 Inclusion criteria

1) Participants were between the ages of 20 (Yale, 1987) and 45 years (Young, Rutherford and Niedfeldt, 2001; Reid, 1992) so that a similar clinical response could be elicited.
2) Participants had a diagnosis of PF based on the following symptoms (Young et al, Rutherford and Niedfeldt, 2001; Barrett and O'Malley, 1999; Brantingham et al., 1992; Reid, 1992 and Noakes, 1985):
    - Maximal pain (induced by digital pressure) located at the antero-medial aspect of the plantar surface of the calcaneus;
    - Pain that is worse on the first few steps in the morning;
    - Aggravation of pain by passive dorsiflexion of the big toe;
    - Aggravation of pain when standing or walking on toes.
3) Participants had a minimum VAS (Visual Analogue Pain Scale) rating of four thus standardising the level of plantar fascia pain experienced by participants so a more accurate conclusion can be drawn from participants with a similar pain rating.
4) Participants must have read, agreed with and signed the Letter of Information and Informed Consent (Appendix B) to partake in the research.
5) Participants were asked to, and agreed to, not wear high heeled shoes for the duration of the study as high heeled shoes can exacerbate the symptoms of plantar fasciitis and therefore influence the results of the study.

3.7 Exclusion criteria

1) Participants were excluded from the study if they received any other form of therapy, manual or medicinal, for their PF during the course of the research period. There was a wash out period of two weeks, for conventional treatment, and three months for involvement with another chiropractic research study. Only after these timeframes were participants considered as legitimate candidates for the study.
2) Participants suffering from systemic disease causing foot pain were excluded from the study (Reid, 1992; Ambrosius and Kondracki, 1992).
3) Any systemic condition with the potential for causing peripheral neuropathy resulted in exclusion from the study.
4) The presence of any contraindications to either Kinesio tape or Low-Dye taping.

5) Participants accepted into the study were asked not to change their lifestyle, daily activities, regular medication or exercise programs to avoid being excluded from the study.

If a participant failed to meet entry requirements into the research process or was excluded at any point in time (at the telephonic interview, at the initial consult, or due to unforeseen circumstances during the research process), or if they wished to continue receiving treatment after the research process had ended, they were informed and referred to another Chiropractic intern at the Chiropractic Day Clinic at DUT to receive appropriate treatment.

3.8 Research procedure

Once a candidate was deemed suitable for inclusion into the study they were randomly allocated to one of two groups by means of a random allocation chart. This is where a computer randomly allocates participants one to thirty to either Group 1 (Kinesio tape group) or Group 2 (Low-Dye tape group). The randomisation table was supplied by a statistician, Dr Michael Hammond in an email communication on 13 September 2012, and held at the Chiropractic Day Clinic reception by a receptionist who had signed an ethical and confidentiality agreement (Appendix K). Participants were allocated to groups according to the randomisation table using concealed allocation to eliminate bias. Group 1 received Kinesio taping and Group 2 received Low-Dye taping.

Table 2: Treatment frequency

Week	**Visit**	**Group 1 (Kinesio tape)**	**Group 2 (Low-Dye tape)**
1	1	• Clinical assessment readings • Ultrasonography reading • Treatment	• Clinical assessment readings • Ultrasonography reading • Treatment
	2	• Clinical assessment readings • Treatment.	• Clinical assessment readings • Treatment
2	3	• Clinical assessment readings • Treatment	• Clinical assessment readings • Treatment
	4	• Clinical assessment readings • Treatment	• Clinical assessment readings • Treatment
3	5	• Clinical assessment readings • Treatment	• Clinical assessment readings • Treatment
	6	• Clinical assessment readings • Treatment	• Clinical assessment readings • Treatment
4	7	• Clinical assessment readings • Ultrasonography reading	• Clinical assessment readings • Ultrasonography reading

Table 2 illustrates the treatment frequency. The study was conducted over a period of four weeks. Each participant was required to attend seven consultations, six of which included treatments and all seven included data collection. The Algometer, WBDF, VAS and FFI data was collected before treatment at each visit and at the final visit, where there was no treatment. The ultrasonography data was collected at the first visit before treatment and at the final visit i.e. Visit 7. Statistical analysis was performed on the collected data to check for significant and insignificant findings.

3.8.1 Visit 1

Demographic data was recorded on the data collection sheet (Appendix G). Subjective measurements were taken using the visual analogue scale (VAS) (Appendix H) and the foot function index (FFI) questionnaire (Appendix I). Objective measures were taken in the form of a weight-bearing ankle dorsiflexion (WBDF) measurement (Appendix J), an algometer reading to measure pain pressure threshold on the PF, and an ultrasonography examination of the plantar fascia to determine its thickness and morphological characteristics.

Participants with bilateral symptoms only received treatment for the foot with the worst symptoms and participants were asked to concentrate on the pain in that foot when completing all outcome measures. Once the data had been recorded on the data collection sheet (Appendix

G) the intervention (Kinesio tape or Low-Dye tape) was administered dependent on group allocation. Participants were asked to keep the tape on for two or three days or until the next scheduled visit.

3.8.2 Visit 2, 3, 4, 5 and 6

Occurred in weeks one to three and were used to administer treatments two, three, four, five and six respectively. There was a minimum of two days between each treatment. Both subjective (VAS and FFI) and Objective (WBDF and algometer) readings were taken at each visit and recorded on the participants' data collection sheet (Appendix G).

8.8.3 Visit 7

This took place in week four and no treatment was administered. Subjective and objective data readings, including a second ultrasonography evaluation of the participants' plantar fascia, were collected and recorded in the participants' data collection sheet (Appendix G).

3.9 Interventions

The Kinesio taping and Low-Dye taping were performed by the researcher who is qualified to perform both. Kinesio taping requires a postgraduate course, which the researcher has completed (Kinesio taping levels 1-3 course, see Appendix M). Low-Dye taping is taught during the DUT academic syllabus in Chiropractic Principles and Practice V (CPPV). Participants were asked to keep the tape on for 2-3 days or until the next scheduled appointment.

3.9.1 Kinesio taping

Kinesio taping of the plantar fascia was administered to Group 1 according to the technique as outlined by Kase, Wallis and Kase (2003). The tape utilised for the Kinesio taping group was 2 inch Kinesio® Tex Gold™. This tape is endorsed by Dr Kenzo Kase the creator of the Kinesio Taping Method.

Figure 2: Kinesio taping for plantar fasciitis
(Kinesiotape, 2010)

- Two strips of Kinesio tape were measured and cut. One strip was measured from the base of the calcaneus to the metatarsals. This strip was then cut into a fan strip (an I-strip which is then cut to have 4-6 longitudinal strips at one end). The other strip was measured from the lateral border of the foot over the cuboid, under the plantar surface of the foot to the anteromedial aspect of the distal third of the tibia. This strip was cut into the traditional I-shaped strip (cut Kinesio tape with rounded edges).
- With the foot placed in dorsiflexion, the anchor of the fan tape was applied at the bottom of the heel with no tension. The 4 fan strips were applied, with 15-25% tension on the tape, to the plantar metatarsal heads of the foot.
- The second strip of Kinesio tape was an I-strip applied on the lateral aspect of the foot with no tension and then with the ankle in dorsiflexion the tape is applied to the arch with 25% tension in an oblique fashion. The rest of the tape on the medial aspect of the ankle was applied with 15-25% tension.

3.9.2 Low-Dye taping

Low-Dye taping of the plantar fascia was administered to Group 2 according to the technique as outlined by Hunt et al., 2004; Saxelby, Betts and Bygrave, 1997; Batt and Tanji, 1995; Ryan 1995; Reid, 1992. The tape utilised was 1.5 inch Mueller EuroTape, a premium rigid strapping tape. This premium rigid strapping is the best quality tape in Australia and is used by athletes around the world (Mueller EuroTape, 2014).

Figure 3: Low-Dye strapping for plantar fasciitis
(Low-Dye taping, 2008)

- Prior to taping, the foot was held in the subtalar neutral position.
- The first tape acts as a forefoot anchor and was applied over the metatarsophalangeal joints (MTPJs).
- The second strip of tape was then applied starting at the dorsolateral aspect of the fifth MTPJ and followed the lateral border of the foot, around the heel, along the medial border of the foot to finish at the dorsomedial aspect of the first MTPJ.
- Three strips of tape were then taken in a teardrop manner around the calcaneus starting at the base of the first MTPJ on the plantar aspect of the foot, following a path diagonally beneath the foot around the heel and then diagonally back beneath the foot finishing at the base of the fifth MTPJ.
- Stirrup strapping was applied transversely across the plantar aspect of the foot starting level with the malleoli and finishing level with the MTPJs, each strap overlapping slightly.
- Finally all the above was secured with another tape passing along the border of the foot (identical to the second taping) to hold the other tape in place and prevent it from losing tension.

3.10 Measurement tools

Participants were monitored and assessed in the form of objective (ultrasonography [US], algometer and weight-bearing ankle dorsiflexion [WBDF]) and subjective (visual analogue scale [VAS] and foot function index [FFI]) data.

3.10.1 Descriptive data

This included the following demographic data: age, race, weight, height, BMI and occupation. These were recorded for statistical purposes.

3.10.2 Objective data

3.10.2.1 Ultrasonography

Ultrasonography (US) was used to determine whether there were any changes in the plantar fascia over the treatment period. US has been found to be the most effective imaging tool in the diagnosis of PF and a useful objective tool to monitor treatment as thickness of the plantar fascia diminishes with successful treatment (Fabrikant and Soon Park, 2011). Scans were taken pre and post treatment to check for any changes in the plantar fascia. All US examinations were performed by a qualified Diagnostic Sonographer (National Diploma Radiography: Diagnostic; National Certificate Radiography US; B.Tech Radiography: Ultrasound) who lectures at DUT and who has more than 20 years of clinical experience nationally and internationally.

The participant was asked to lie in the prone position with both feet dorsiflexed and hanging off the examination bed. First images of the contralateral achilles tendon, calcaneus and plantar fascia were taken so they could be compared to the affected side. The affected foot was then imaged. Images were taken in both the longitudinal and transverse planes and colour Doppler US was utilised where there was increased thickening of the plantar fascia to confirm presence of inflammation. Measurements were taken at the point of maximum thickness and measured in millimeters (mm). Comments on the appearance of the plantar fascia were also noted. This included signs of inflammation, echogenicity and presence of heel spurs or other abnormalities (Appendix G). This measure was done at the initial consultation before treatment and other readings were taken and again at the final consultation after the treatment period.

The Siemens ACUSON X300 Ultrasound System, premium edition was used to sonographically image participants. A 13.5 MHz transducer was used and the settings utilised included tissue harmonics and spatial compounding to improve the image resolution. Lower frequencies, up to 9 MHz, were used in participants that had a thicker heel to better visualise the plantar fascia. The unit has colour Doppler US facilities which were used to check for and confirm inflammation. The images were all stored for comparisons to be made at the second US visit.

3.10.2.2 Algometer

The algometer (Push-Pull force gauge, Wagner Instruments, P.O. Box 1217, Greenwich, CT 06836 U.S.A.) is an objective measurement tool used to measure each participant’s pain pressure threshold (PPT) which is the minimum pressure inducing pain or discomfort (Ylinen, 2007). The algometer can be used for diagnostic purposes and for the evaluation of treatment results (Vanderweeën et al., 1996) and has a good inter-examiner and intra-examiner reliability (Antonaci, Sand and Lucas, 1998).

The reading was taken over the point of maximum tenderness as per Blake (2003), Dunn (2005) and Maartens (2005), usually located over the antero-medial calcaneal tubercle at the insertion of the plantar fascia. The algometer would be set to zero and placed on the most tender spot, found using digital palpation of the plantar fascia. Pressure was slowly increased until the participant first perceived pain indicating their pain pressure threshold. This value was then recorded in the data collection sheet (Appendix G). The above procedure was repeated with a second value recorded so a mean could be calculated from the two readings. This value was then recorded and used for data purposes. This procedure was repeated at each visit before treatment to monitor a participant’s improvement or worsening of symptoms.

An improvement would be indicated by the participants’ ability to withstand increased pressure from the algometer and a higher PPT reading and conversely a lower PPT value would indicate a worsening of the symptoms. With regards to MCID (minimal clinically important difference) an improvement of 1.77 kg/cm^2 was regarded as being deemed clinically significant (Chesterton et al., 2007).

3.10.2.3 Weight-bearing ankle dorsiflexion measurement

Weight-bearing ankle dorsiflexion has been shown to be a valid and reliable measure with a high inter-examiner and intra-examiner reliability when used to measure weight-bearing ankle dorsiflexion in an injured population (Jones et al., 2005). The weight-bearing dorsiflexion ankle measurement (Appendix J) was used as per Blake (2003), Maartens (2005) and Dunn (2005). The method for measurement was as per Blake (2003): participants stood on the involved leg and dorsiflexed the ankle while flexing the knee, up to a point where no further dorsiflexion could occur without lifting the heel from the ground. A large set square was used to measure the horizontal distance (x) from the back of the heel to the front of the knee and the vertical distance (y) from the ground to the front of the knee. The degree of ankle dorsiflexion was calculated using simple trigonometry: $\tan \boldsymbol{\theta} = y/x$.

3.10.3 Subjective data

3.10.3.1 The visual analogue scale (VAS)

The VAS (Appendix H) was used to evaluate the participants' perception of foot pain. The VAS is a well established outcome measure of pain intensity (Crossley et al., 2004; Price et al., 1994; Price et al., 1983 and Merskey 1973). It involves the use of an unmarked horizontal line 10 cm in length, to evaluate the participants perception of pain based on a description at each end of the horizontal line; 0 at one end representing no pain and 100 at the other end representing pain at its worst (Yeomans and Liebenson, 1996). The participant was asked to indicate on the line the intensity of their pain. The researcher then used a ruler to measure where the mark was made indicating the participant's pain this was measured in millimeters and recorded at each consultation on the data collection sheet (Appendix G).

The VAS has a high level of responsiveness, reliability and validity permitting detection of clinically relevant changes, an essential measurement for clinical trials (Reading, 1980). A mean reduction in VAS of 20-25 mm (subacute to chronic patients) has been shown to represent a clinically important difference in pain severity generally (Lee et al., 2003) and more recently Landorf and Radford (2008) determined the VAS for foot pain specifically, to be an improvement of 9 mm. Based on this a mean reduction of 9 mm in VAS will be considered as a MCID as plantar fasciitis is recalcitrant in nature (Puttaswamaiah and Chandran, 2007; Hunt et al., 2004). Therefore this research will consider both delineations in the statistical analysis.

3.10.3.2 The Foot Function Index (FFI)

The FFI (Appendix I) was used as per Blake (2003), Maartens (2005) and Dunn (2005) to obtain information on the impact of participants' foot pain on their daily activities, noting improvement or worsening of functional ability over the course of the treatment. The FFI (Appendix I) is a recognised, validated and reliable scale for measuring foot pain, disability and activity restriction in orthopaedic interventional trials (Saag et al., 1996). It comprises 14 questions the participants were required to read and answer regarding their foot pain, each question being scored from 0 (no pain) to 10 (worst pain imaginable). There are three sections in the FFI; section A relates to pain, section B to disability and section C to activity limitation. Before each treatment the participant was required to answer the FFI to monitor the progression or regression of the participant's pain levels in response to treatment.

The MCID in the Total Foot Function Index score (a summative measure of all FFI sub-scales) was shown to be 7 (Landorf and Radford, 2008). Landorf and Radford (2008) also reported the minimal important difference for the sub-scales of the FFI to be an improvement of 12 points in section A (pain), 7 points section B (disability) and section C (activity limitation) was shown to have a minimal important difference of essentially 0, indicating that for a condition like PF this subscale was inappropriate.

3.11 Statistical methods

Data collected from the algometer, weight-bearing dorsiflexion, ultrasonography, VAS and FFI were all recorded in the data collection sheet (Appendix G) and sent to a statistician for statistical analysis.

SPSS version 21 (SPSS Inc., Chicago, III, USA) was used to analyze the data. A p value of < 0.05 was considered to be statistically significant. Demographics and baseline values were compared between groups using independent t-tests and chi square tests. Repeated measures ANOVA tests were used to assess the effect of the difference in treatment groups over time (time x group effects). Profile plots were used to assess the trends visually. McNemar chi square tests for paired groups were applied intra-group to assess the change from ‘yes’ to ‘no’ on the ultrasound thickening variable. FFI items were summed at each time point to create a total FFI score for each time point and compared between the groups.

CHAPTER 4: RESULTS

4.1 Introduction

In this chapter the statistical findings and results obtained from the data collected will be presented. It includes demographic data, objective data (algometer, weight bearing ankle dorsiflexion and ultrasonography measures) and subjective data (VAS and FFI). The results collected are presented in tabulated and graphical form

4.2 Demographics

4.2.1 Gender

Table 3: Gender

			GENDER		Total
			Male	Female	
Group	Kinesio tape	Number	5	10	15
		%	33.30%	66.67%	100.00%
	Low-Dye tape	Number	4	11	15
		%	27%	73.30%	100.00%
Total		Number	9	21	30
		%	30.00%	70.00%	100.00%

Table 3 shows the gender distribution between the groups in which there was no significant difference between the groups in the percentage of males and females in each group (p = 1.00). In total there were 9 male (30%) and 21 female (70%) participants in the study.

4.2.2 Race

Table 4: Race

			RACE		Total
			White	Indian	
		Number	13	2	15
	Kinesio tape	%	86.67%	13.33%	100.00%
		Number	12	3	15
Group	Low-Dye tape	%	80%	20.00%	100.00%
		Number	25	5	30
Total		%	83.33%	16.67%	100.00%

Table 4 shows there was no significant difference in the racial distribution between the groups (p = 1.00). The majority of the participants in the study were White (83.33%). Indian participants made up the remainder 16.67% of participants. There were no Coloured or Black participants.

4.2.3 Age, weight, height and BMI

Table 5: Age, height, weight and BMI

Group Statistics						
	Treatment group	N	Mean	Std. Deviation	Std. Error Mean	P value
Age (yrs)	Kinesio tape	15	30.27	7.196	1.858	0.873
	Low-Dye tape	15	29.87	6.390	1.650	
Height (m)	Kinesio tape	15	1.7100	.12638	.03263	0.211
	Low-Dye tape	15	1.6567	.10033	.02591	
Weight (kgs)	Kinesio tape	15	79.733	24.7198	6.3826	0.186
	Low-Dye tape	15	69.493	15.6283	4.0352	
BMI [wt/(ht)^2]	Kinesio tape	15	27.1163	7.43705	1.92024	0.404
	Low-Dye tape	15	25.1895	4.73515	1.22261	

Table 5 shows there was no significant difference in age (p = 0.873), height (p = 0.211), weight (p = 0.186) and BMI (0.404). The oldest participant in the study was 41 while the youngest participant was 20 years old. In this study the average age was found to be 30.06 years. The height of participants ranged from 1.52 m to 1.91 m with an average of 1.683 m. The average weight was 74.613 kg, with the lowest measured at 43 kg and the highest at 148 kg.

The formula for BMI is BMI = body mass (kg) ÷ height (m^2). Categories for BMI are considered as follows; Underweight < 18.5, normal 18.5-24.9, overweight 25-29.9, obese 30-39.9 and morbidly obese > 40 (Douglas, Nicol and Robertson, 2005).The average for BMI was found to be 26.1528 (overweight), with values ranging from 18.61 (underweight) to 48.88 (morbidly obese).

4.2.4 Occupation

Table 6: Occupation of study participants by group

Occupation	Kinesio tape		Low-Dye tape		Total	
Automotive	1	6.7%	0	0.0%	1	3.33%
Bookkeeper	0	0.0%	1	6.7%	1	3.33%
Candidate attorney	1	6.7%	2	13.3%	3	10.00%
Category manager	0	0.0%	1	6.7%	1	3.33%
Chiropractor	1	6.7%	2	13.3%	3	10.00%
Client liaison	0	0.0%	1	6.7%	1	3.33%
Financial Advisor	1	6.7%	0	0.0%	1	3.33%
Insurance broker	1	6.7%	0	0.0%	1	3.33%
Lawyer	1	6.7%	0	0.0%	1	3.33%
Legal secretary	1	6.7%	0	0.0%	1	3.33%
Manageress	1	6.7%	0	0.0%	1	3.33%
Marketing	0	0.0%	2	13.3%	2	6.67%
Marketing and operations manager	0	0.0%	1	6.7%	1	3.33%
Paralegal	0	0.0%	1	6.7%	1	3.33%
Secretary	1	6.7%	1	6.7%	2	6.67
Skin and Health care distributor	1	6.7%	0	0.0%	1	3.33`%
Student	4	26.7%	2	13.3%	6	20.00%
Teacher	1	6.7%	1	6.7%	2	6.67%

Table 6 shows that no single occupation formed a majority among the participants; however, students formed the largest percentage in the study with 20.0% of total participants and 26.7% in the Kinesio tape group and 13.3% in the Low-Dye group. Candidate attorneys and Chiropractors came in joint second both forming 10.0% of total participants in the study with each having 6.7% of participants the Kinesio tape group and 13.3% in the Low-Dye group respectively.

4.2.5 Level of physical activity

Table 7: Level of physical activity

			Level of physical activity			Total
			non-athlete	recreational	serious	
Group	Kinesio tape	Number	2	6	7	15
		%	13.30%	40.00%	46.70%	100.00%
	Low-Dye tape	Number	4	8	3	15
		%	26.7%	53.30%	20.00%	100.00%
Total		Number	6	14	10	30
		%	20.00%	46.67%	33.33%	100.00%

p = 0.279

Table 7 shows the level of physical activity category distribution between the groups in which there was no significant difference between the groups in the percentage of non-athletes, recreational or serious athletes in each group (p = 0.279). There were 6 non-athletes (20%), 14 recreational athletes (46.67%) and 7 serious athletes (23.33%) in total in the study.

4.2.6 Shoes most commonly worn

Table 8: Shoes most commonly

			Shoes most commonly worn			Total
			high-heels	slops	work	
Group	Kinesio tape	Number	2	5	8	15
		%	13.30%	33.30%	53.30%	100.00%
	Low-Dye tape	Number	0	2	13	15
		%	0.00%	13.30%	86.70%	100.00%
Total		Number	2	7	21	30
		%	6.67%	23.33%	70.00%	100.00%

p = 0.107

Table 8 shows the shoes most commonly worn between groups. There was no significant difference between the groups in the percentage of participants who wore high-heels, slops or work shoes in each group (p = 0.107). In total there were 2 participants (6.67%) who wore high-heels, 7 wore slops (23.33%) and 21 (70%) who wore work shoes.

4.2.7 Sidedness of the PF

Table 9: Sidedness of foot affected with PF

			Side affected			Total
			Left	Right	(Both)	
Group	Kinesio tape	Number	7	8	(6)	15
		%	46.67%	53.33%	(40.00%)	100.00%
	Low-Dye tape	Number	6	9	(6)	15
		%	40.00%	60.00%	(40.00%)	100.00%
Total		Number	13	17	(12)	30
		%	43.33%	56.67%	(40.00%)	100.00%

p = 1.00

Table 9 shows the sidedness of the foot affected by group. There was no significant difference in sidedness proportions by group (p = 1.00). The right foot was affected in 17 (56.67%) participants, while the left foot was affected in 13 (43.33%) participants. Based on sidedness both groups had six (40%) participants with bilateral foot involvement, with the foot affected worst used in the study. Participants with bilateral foot involvement were noted for statistical purposes.

4.2.8 Conclusion on demographic data

There were no statistically significant differences between the two groups with respect to demographic data.

The sample showed that the most common demographic with PF in this study to be White, female, student, recreational athletes who most commonly wore work shoes, were 30 years old, between 1.65-1.71 m tall, weighed 69-79 kgs with a BMI classified as overweight with PF in their right foot

4.3 Objective clinical findings

This section covers the objective tests used as outcome measures and includes: algometer measurements, weight bearing ankle dorsiflexion (WBDF) measurements and ultrasonography (US) measurements. Repeated measures ANOVA tests were used to assess the effect of the difference in treatment groups over time (time x group effects). Profile plots were used to assess the trends visually. McNemar chi square tests for paired groups were applied intra-group to assess the change from ‘yes’ to ‘no’ on the ultrasonography thickening variable.

4.3.1 Algometer reading

Table 10: Algometer effects within and between groups

Effect	Statistic	P value
Time	Wilk’s lambda = 0.436	0.002
Time x group	Wilk’s lambda = 0.778	0.396
Group	F = 0.073	0.790

Table 10 shows that there was no significant time x group treatment effect between the groups for algometer readings ($p = 0.396$). Therefore there was no evidence for a difference in effect between the two treatments. The effect of time was statistically significant ($p = 0.002$) which means that both groups both changed significantly in mean algometer measurements over time. This progressive increase in algometer readings over the study period reflects a decrease in tenderness.

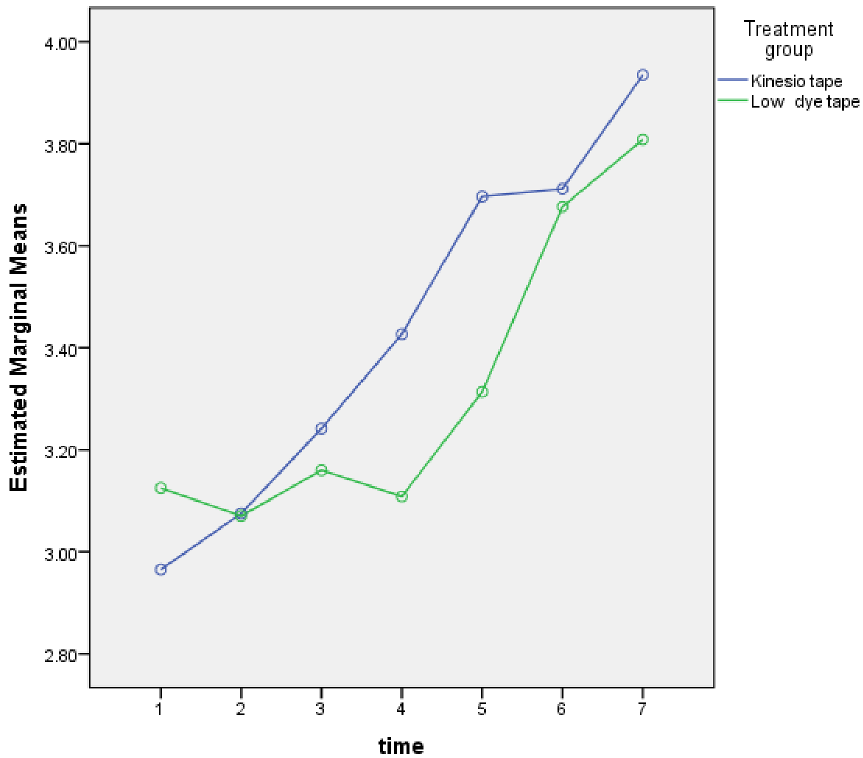

Figure 4: Profile plot of mean algometer readings over time by group

Figure 4 shows that both groups had the same mean algometer readings at Visit 2 and nearly identical readings at Visit 6. The Kinesio taping group showed a larger improvement in algometer readings from Visit 2 onwards and was always slightly above the mean Low-Dye algometer readings.

4.3.2 Weight-bearing ankle dorsiflexion (WBDF)

Table 11: Weight-bearing ankle dorsiflexion effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.609	0.055
Time x group	Wilk's lambda = 0.714	0.212
Group	F = 1.15	0.292

Table 11 shows that there was no significant time x group treatment effect of the intervention for WBDF between the two groups ($p = 0.212$). Therefore there was no evidence for a difference in effect between the two treatments. There was no significant effect over time ($p = 0.055$). This means that both groups did not show a statistically significant change in WBDF measurements over time.

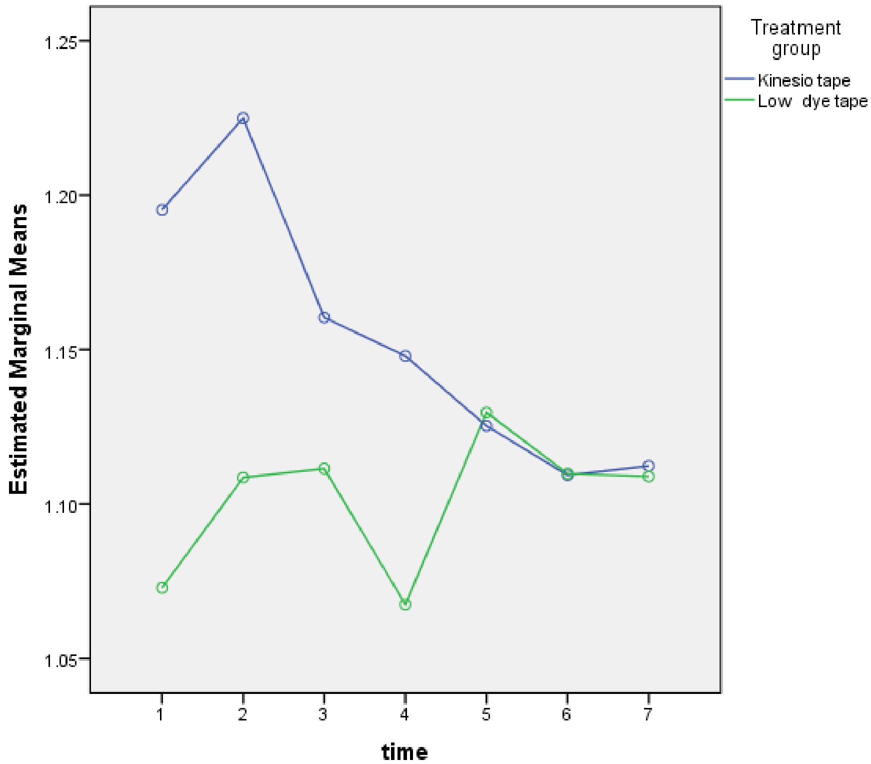

Figure 5: Profile plot of mean weight-bearing ankle dorsiflexion readings over time by group

Figure 5 shows the Kinesio tape group showed a trend to decrease mean WBDF values over time. The Low-Dye group showed an overall slight increase over time although the values were very similar and there was no significant change between the first and last visits which indicates little improvement. Both groups showed nearly identical WBDF measurements at Visit 5, 6 and 7.

4.3.3 Ultrasonography of the plantar fascia

Table 12: Thickness of affected foot on ultrasonography effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.608	< 0.001
Time x group	Wilk's lambda = 0.914	0.116
Group	F = 0.077	0.783

Table 12 shows that there was a significant decrease in thickness of the affected foot in both groups over time (p < 0.001) but that no difference between the groups over time (p = 0.116) indicating that there was no significant treatment effect when comparing the treatments.

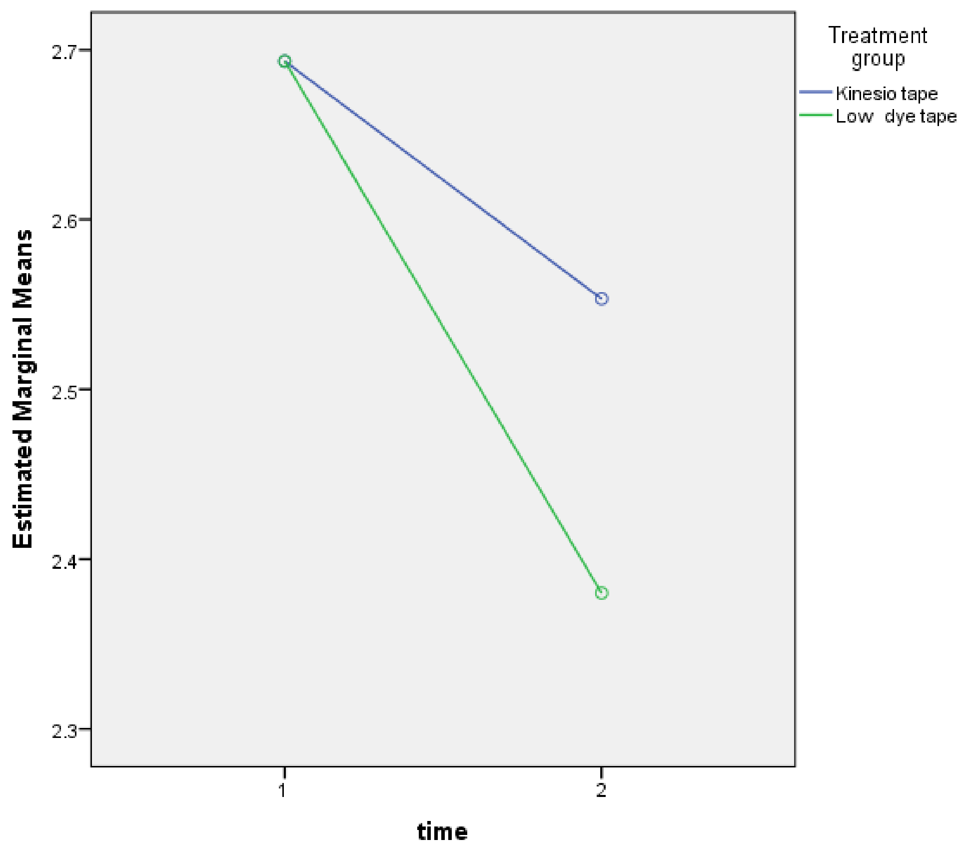

Figure 6: Profile plot of thickness of affected foot on ultrasonography over time by group

Figure 6 illustrates there was a trend for the Low-Dye tape group to show a faster rate of decrease than the Kinesio tape group. Both groups showed a decrease in the thickness of the plantar fascia over time between the ultrasonography readings at Visit 1 and Visit 7.

Table 13: Presence of thickening on ultrasonography within and between groups

			Thickening					
			Visit 1			Visit 7		
			Yes	No	Total	Yes	No	Total
Group	Kinesio tape	Number	9	6	15	5	10	15
		%	60.00%	40.00%	100.00%	33.33%	66.67%	50.00%
	Low-Dye tape	Number	11	4	15	7	8	15
		%	73%	26.67%	100.00%	46.67%	67.67%	50.00%
Total		Number	20	10	30	12	18	30
		%	70.00%	30.00%	100.00%	40.00%	60.00%	100.00%

Table 13 shows that before treatment commenced 20 of the total participants (70.0%) had thickening of the plantar fascia when compared to the unaffected foot, with 10 of the total participants (30.0%) having no thickening. At visit 7, after the treatment period, 12 of the total participants (40.0%) had thickening of the plantar fascia compared to 18 of the total participants (60.0%) who had no thickening, when compared to the normal foot. Table 10 also shows the statistically significant time effect ($p < 0.001$) for both groups at reducing the thickness of the plantar fascia. In Figure 6 this is visible as steadily declining plots illustrating a decreased plantar fascia thickness for both the Kinesio tape and Low-Dye taping group.

Table 14: Presence of thickening of plantar fascia Chi-Square Tests between groups

Chi-Square Tests			
Treatment group		Value	Exact Sig. (2-sided)
Kinesio tape	McNemar Test		.125[a]
	N of Valid Cases	15	
Low-Dye tape	McNemar Test		.125[a]
	N of Valid Cases	15	
Total	McNemar Test		.008[a]
	N of Valid Cases	30	
a. Binomial distribution used.			

The change from ‘yes’, indicating presence of thickening, to ‘no’, indicating no thickening, from baseline to post intervention was the same in both groups (p = 0.125 in each group) (Table 14) and the change overall was statistically significant (p = 0.008); therefore there was a significant improvement overall, regardless of which treatment was received.

Additional findings on US showed that four of the total participants (13.33%) had heel spurs present – one participant (6.66%) in the Kinesio taping group and three participants (20.0%) in the Low-Dye taping group.

4.3.4 Conclusion for objective measures

There were no statistically significant differences between the two groups with respect to objective data. Both groups showed significant reduction in the algometer and WBDF measurements over time. Although no group was statistically superior the Kinesio tape group showed larger improvements over time for both algometer and WBDF measurements. On ultrasonography both groups significantly decreased the thickness of the plantar fascia over time although no group was statistically superior the Low-Dye group showed a faster rate of decrease than the Kinesio tape group.

4.4 Subjective clinical findings

In this section the subjective tests that were used as measurers are covered. The subjective measurers include the VAS and the FFI. Repeated measures ANOVA tests were used to assess the effect of the difference in treatment groups over time (time x group effects) and profile plots were used to assess the trends visually.

4.4.1 Visual analogue scale (VAS)

Table 15: VAS effects within and between groups

Effect	Statistic	P value
Time	Wilk’s lambda = 0.215	< 0.001
Time x group	Wilk’s lambda = 0.521	0.013
Group	F = 0.828	0.371

Table 15 illustrates that there was a statistically significant change over time for both groups ($p < 0.001$) and that there was a statistically significant treatment effect showing the Kinesio tape group improving better than the Low-Dye group ($p = 0.013$).

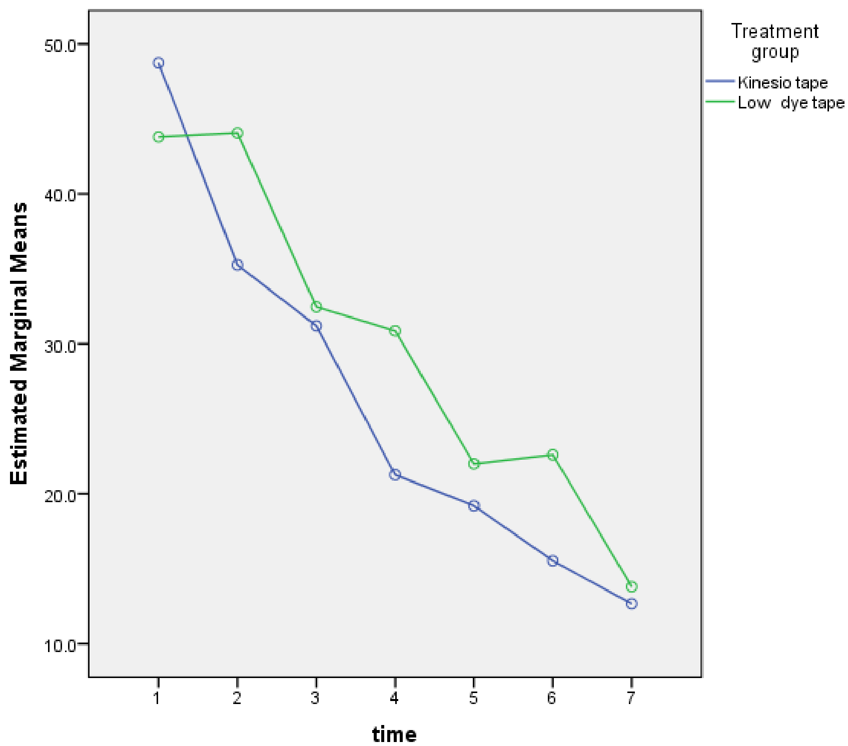

Figure 7: Profile plot of mean VAS over time by group

Figure 7 illustrates that both groups showed a general decrease in VAS values over time meaning a reduction in participants' perceived pain. The Kinesio tape group values decreased at a faster rate than those of the Low-Dye tape group. The Kinesio group showed decreased VAS readings at each subsequent visit. The Low-Dye group showed no change between Visits 1 and 2, a decrease between Visits 2, 5, 6 and 7, and an increase between Visits 5 and 6.

4.4.2 The foot function index (FFI)

The FFI is comprised of 14 questions which participants were required to answer relating to pain, disability and activity limitation. A statistical analysis was made on each individual question, on each section and on the FFI as a whole.

4.4.2.1 FFI total score

The FFI total score took into consideration all the FFI pain values. This included 12 questions in two sections regarding pain and disability.

Table 16: FFI Total score effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.236	< 0.001
Time x group	Wilk's lambda = 0.742	0.283
Group	F = 0.005	0.946

Table 16 shows there was a significant decrease over time in both groups (p < 0.001) indicating that both groups decreased the total FFI score over time. However there was no treatment effect as the time x group was non-significant (p = 0.283).

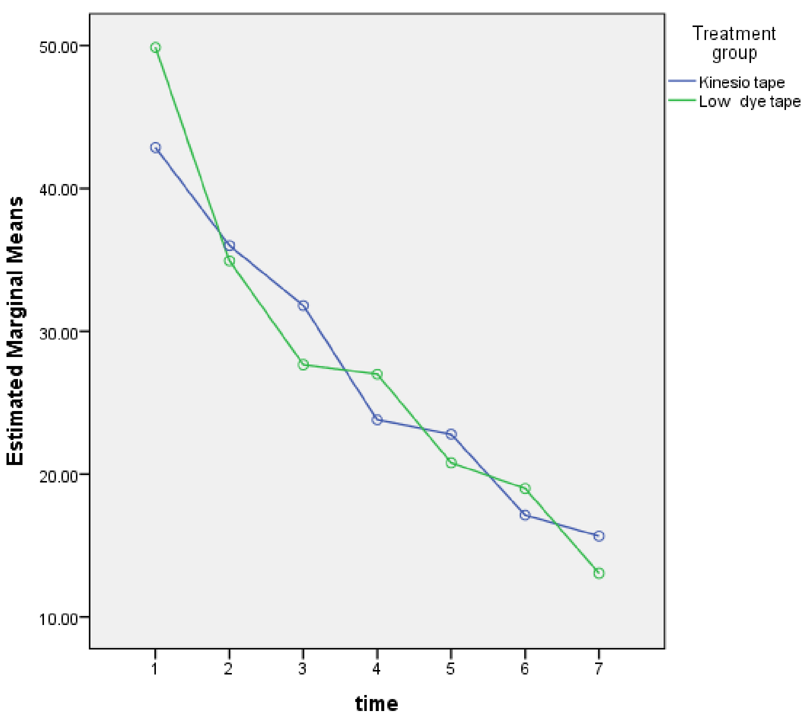

Figure 8: Profile plot of mean FFI total score readings over time by group

Figure 5 shows that both groups reduced the FFI total score, indicating impairment of foot functioning, over time with almost parallel profile plot gradients. The Low-Dye group showed a larger overall reduction although this was non-significant.

4.4.2.2 FFI: Total Pain Score

The FFI: Total Pain Score is the total score for the pain section of the FFI. It includes the first five questions of the FFI: worst pain, morning pain, pain walking barefoot, pain walking with shoes and pain standing with shoes. The total pain score will be presented first followed by each individual question of the pain section of the FFI.

Table 17: FFI Total Pain Score effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.247	< 0.001
Time x group	Wilk's lambda = 0.623	0.076
Group	F = 0.037	0.849

Table 17 indicates there was a significant decrease over time in both groups ($p < 0.001$). This means that in both groups there was a decrease in total pain score over time. However the time x group was non-significant between the groups ($p = 0.076$) which indicates a lack of treatment effect.

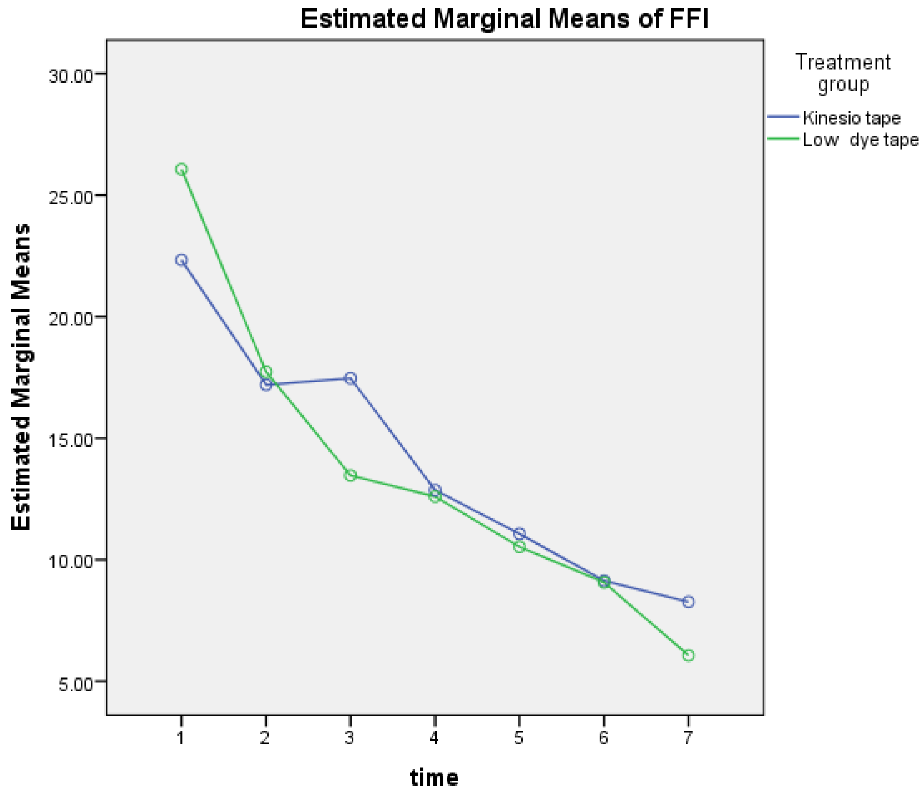

Figure 9: Profile plot of mean Total Pain Score readings over time by group

Figure 9 shows that the Low-Dye group decreased at a slightly faster rate than the Kinesio tape group. The Low-Dye group values decreased at each visit. The Kinesio group showed an increase in values between Visits 2 and 3, but this was marginal and there was a decrease in total pain between every other visit. At Visit 4, 5 and 6 the groups are nearly identical.

4.4.2.3 Worst pain

Table 18: Worst pain effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.185	< 0.001
Time x group	Wilk's lambda = 0.822	0.560
Group	F = 0.003	0.959

Table 18 shows there was a significant improvement in both groups over time ($p < 0.001$) indicating a decrease in worst pain in both groups over time. There was no significant time x group effect for worst pain ($p = 0.560$) which indicates a lack of treatment effect.

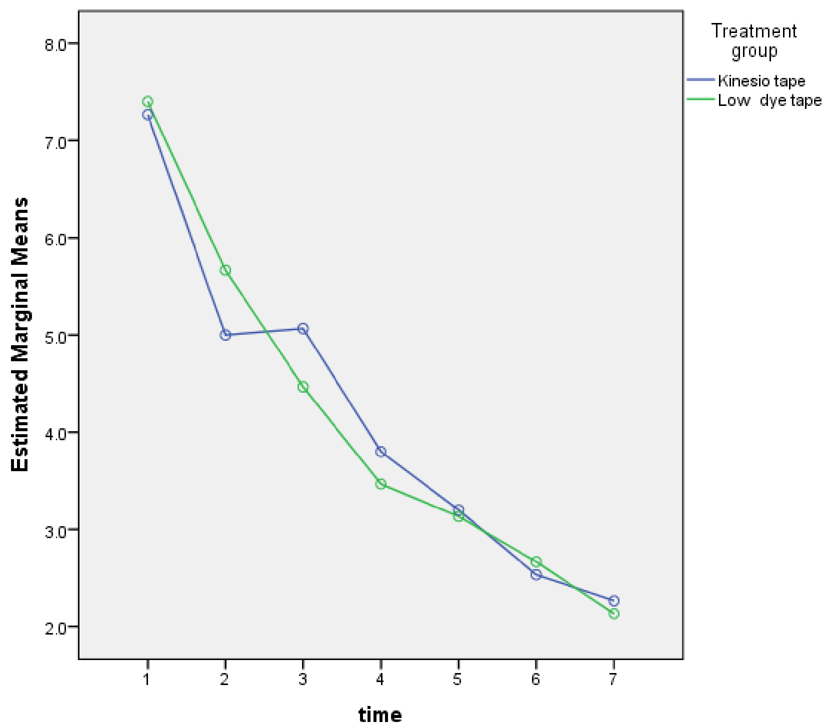

Figure 10: Profile plot of mean worst pain readings over time by group

The patterns of the two groups appear parallel in Figure 10, apart from a slight increase in pain perception between Visits 1 and 2 in the Kinesio group. Between all other visits there was a decrease in worst pain in both the Kinesio group and the Low-Dye group.

4.4.2.4 Morning pain

Table 19: Morning pain effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.402	0.001
Time x group	Wilk's lambda = 0.584	0.045
Group	F = 0.795	0.381

Table 19 shows there was significant improvement with both groups over time regarding this outcome (p = 0.001) There was a significant differential effect of the treatment for morning pain (p = 0.045) with the Low-Dye group improving at a faster rate than the Kinesio group.

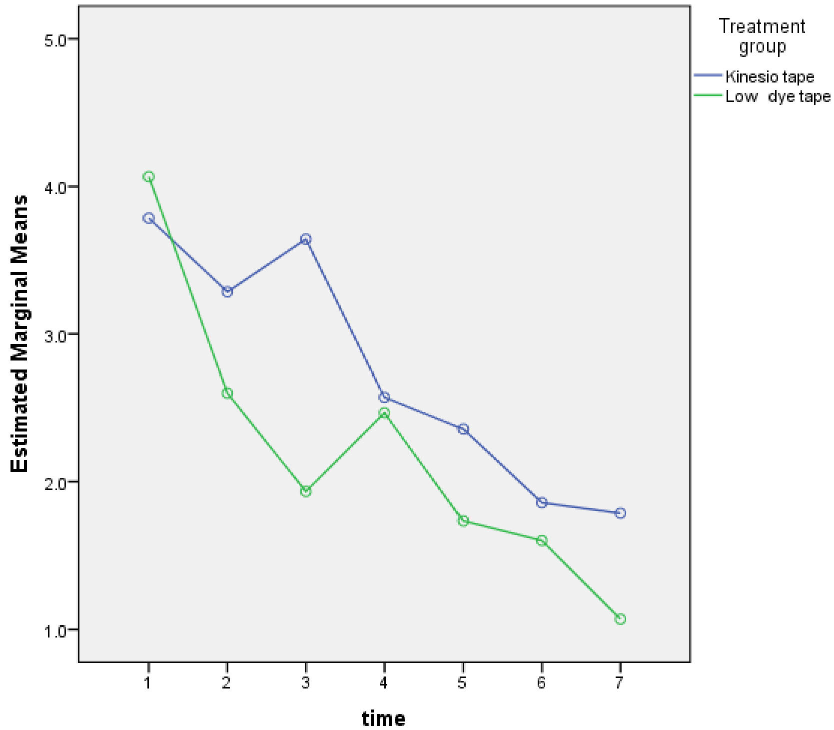

Figure 11: Profile plot of mean morning pain readings over time by group

Figure 11 shows that the Low-Dye group had a faster rate of improvement than the Kinesio tape group. Both groups showed an increase in readings between certain visits. Morning pain increased between Visits 2 and 3 for Kinesio tape, and between Visits 3 and 4 for the Low-Dye group.

4.4.2.5 Pain walking barefoot

Table 20: Pain walking barefoot effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.284	< 0.001
Time x group	Wilk's lambda = 0.720	0.225
Group	F = 0.022	0.882

Table 20 shows both groups improved significantly over time (p < 0.001). Although they improved to the same extent there was no evidence of differential treatment effect with the time x group being non-significant (p = 0.225).

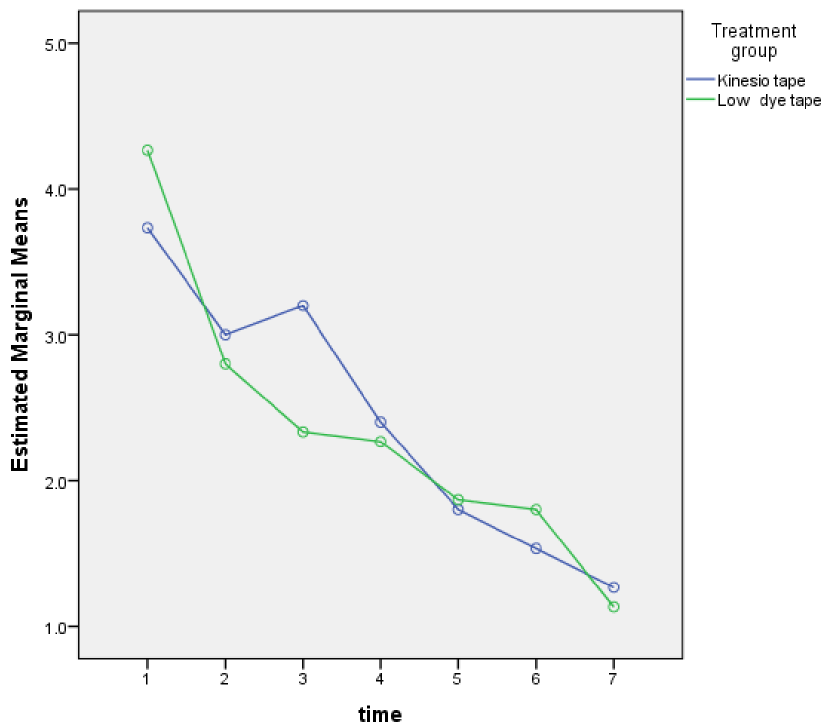

Figure 12: Profile plot of mean pain walking barefoot readings over time by group

Figure 12 shows both groups had a decrease in pain on walking barefoot over time. The Kinesio tape group showed an increase in pain walking barefoot between Visits 2 and 3.

4.4.2.6 Pain walking with shoes

Table 21: Pain walking with shoes effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.293	< 0.001
Time x group	Wilk's lambda = 0.651	0.099
Group	F = 0.128	0.733

Table 21 shows there was a significant time effect (p < 0.001) showing that both groups improved over time. There was no evidence of a differential treatment effect with both groups improving to a similar extent over time. The time x group level was non-significant (p = 0.099)

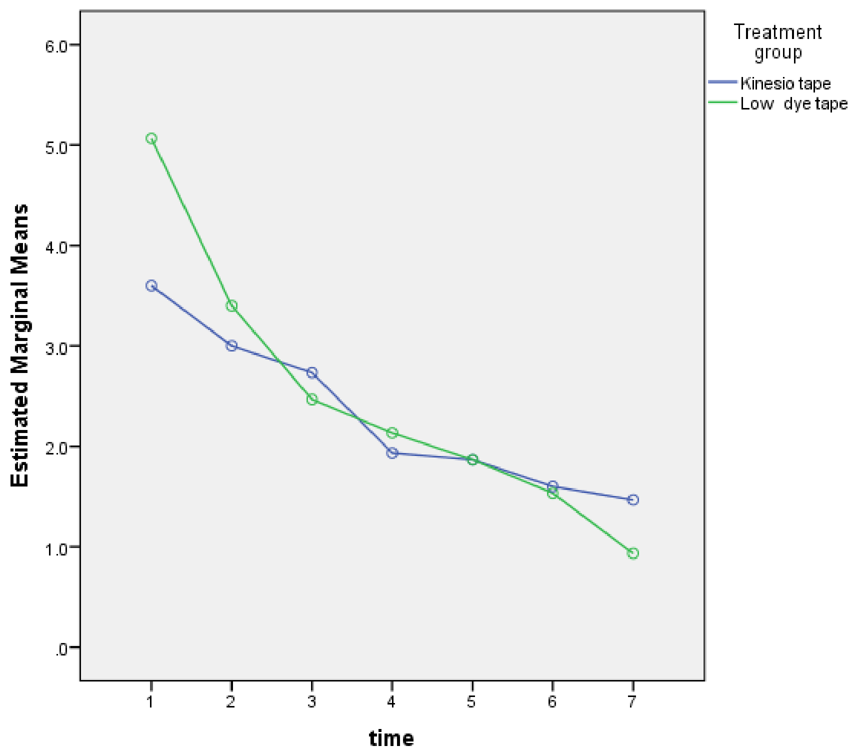

Figure 13: Profile plot of mean pain walking with shoes readings over time by group

Figure 13 shows that there was a non-significant trend that the Low-Dye group improved at a faster rate than the Kinesio tape group. Both groups showed improvements in pain walking in shoes at each subsequent visit.

4.4.2.7 Pain standing with shoes

Table 22: Pain standing with shoes effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.296	< 0.001
Time x group	Wilk's lambda = 0.642	0.088
Group	F = 0.023	0.881

Table 20 shows there was a statistically significant change over time ($p < 0.001$) for both groups showing that both groups decreased pain standing in shoes over time. But there was no evidence for a differential treatment effect as the time x group was non-significant ($p = 0.088$).

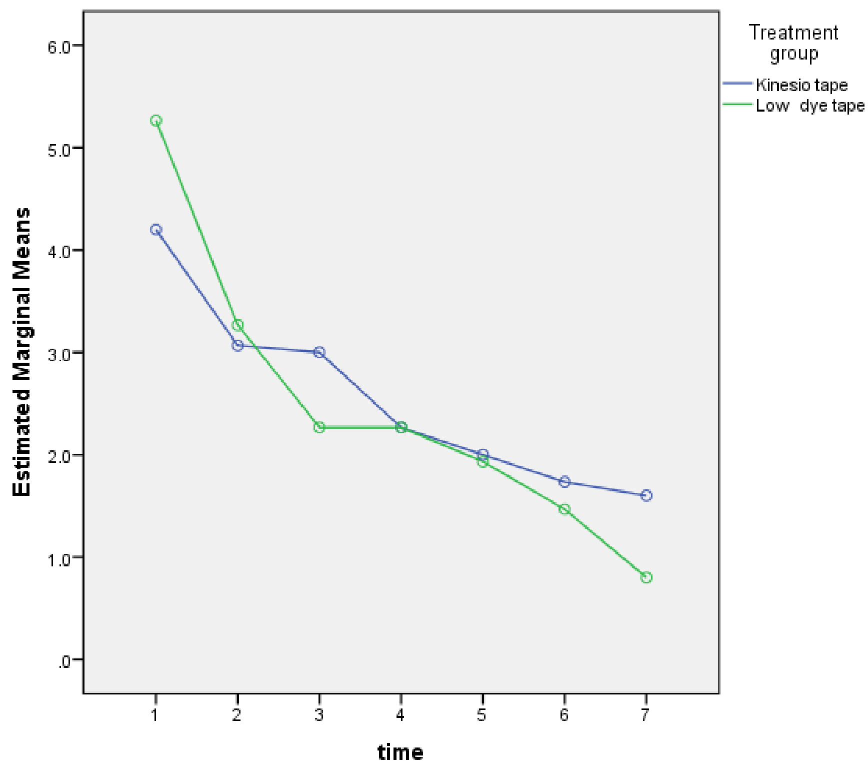

Figure 14 : Profile plot of mean pain standing with shoes readings over time by group

The nearly parallel lines of Figure 14 indicate the two groups both improved to a similar non-statistically significant extent over time. Figure 14 also shows that there was a non-significant trend that the Low-Dye group improved at a faster rate than the Kinesio group.

4.4.2.8 Conclusion for FFI: Total Pain Score

All questions relating to FFI: Total Pain Score showed a statistically significant reduction over time ($p \leq 0.001$). All pain scores showed a reduction between Visit 1 and Visit 7. The only question that showed a significant time by group effect in the pain section of the FFI was morning pain where the Low-Dye group showed a faster rate of improvement than the Kinesio group. None of the other questions in the pain section of the FFI showed a time by group treatment effect. There were non-significant trends for the Low-Dye group to show better improvement than the Kinesio tape group for the FFI: Total Pain Score. No group was statistically superior to the other in the treatment of PF with regards to FFI: Total Pain Score.

4.4.2.8 FFI: Total Disability Score

The Total Disability Score was worked out by using all the questions that fell under the disability section in the FFI. The questions included: pain walking in the house, pain walking outside, pain climbing stairs, pain descending stairs, pain standing on tiptoe, pain getting up from a chair, and pain climbing curbs.

Table 23: Total Disability Score effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.362	< 0.001
Time x group	Wilk's lambda = 0.655	0.104
Group	F = 0.053	0.819

Table 23 shows that there was a significant time effect ($p < 0.001$) which shows that there was a significant decrease over time in both groups with regards to Total Disability Score. There was no significant time x group treatment effect for total disability score ($p = 0.104$).

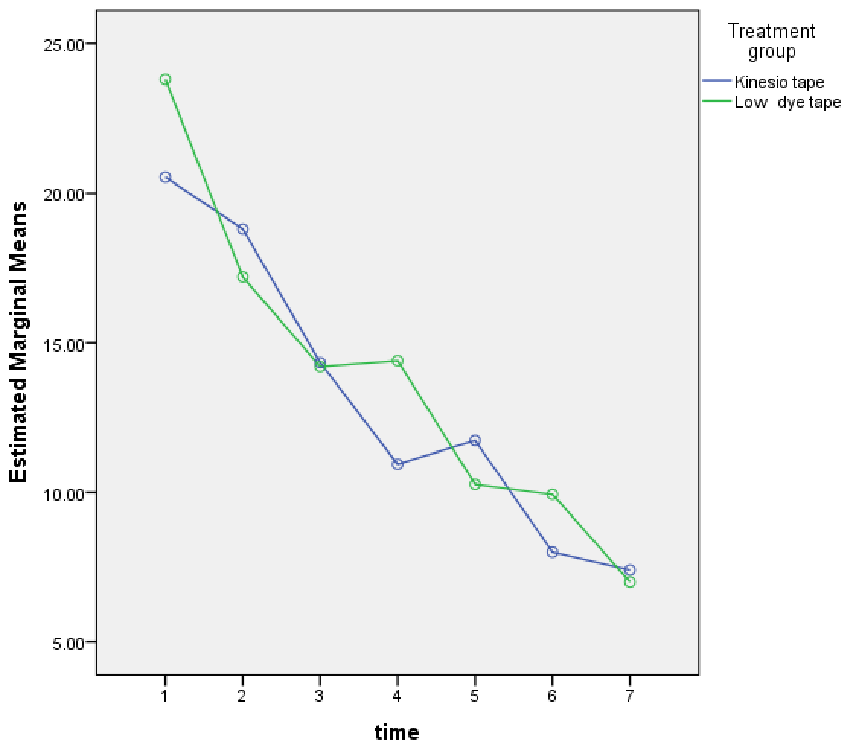

Figure 15: Profile plot of mean total disability score readings over time by group

Figure 15 shows that for both groups there was an overall trend to decrease total disability scores between visits, with one fluctuation in both groups, meaning an improvement in disability rating of participants in both groups. The Low-Dye group showed a slight increase in overall disability score between Visits 3 and 4; similarly, the Kinesio group showed an increase between Visits 4 and 5. The similar profile plot gradients indicate that both groups decreased the Total Disability Score at a similar rate.

4.4.2.9 Pain walking in the house

Table 24: Pain walking in the house effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.473	0.005
Time x group	Wilk's lambda = 0.675	0.134
Group	F = 0.029	0.867

Table 24 shows that the time effect was nearly significant (p = 0.005) and there was no evidence of differential treatment effect with the time x group effect being non-significant (p = 0.134)

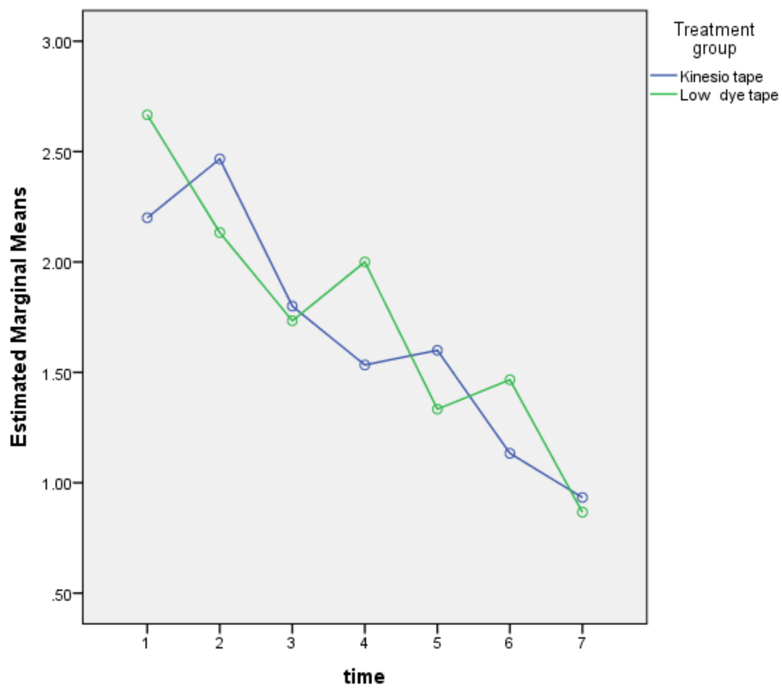

Figure 16: Profile plot of mean pain walking in the house readings over time by group

Figure 13 shows that the profile plot gradients of the two groups showing a similar pattern between treatment visits. The Low-Dye group showed a faster decline in pain walking in the house for the first two visits, but overall the groups showed a similar fluctuating pattern.

4.4.2.10 Pain walking outside

Table 25: Pain walking outside effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.437	0.002
Time x group	Wilk's lambda = 0.597	0.046
Group	F = 0.080	0.780

Table 25 shows there was a significant time effect (p = 0.002) showing that both groups decreased the pain walking outside value. There was a significant differential effect of the treatment for pain walking outside (p = 0.046) with the Kinesio group improving at a faster rate than the Low-Dye group.

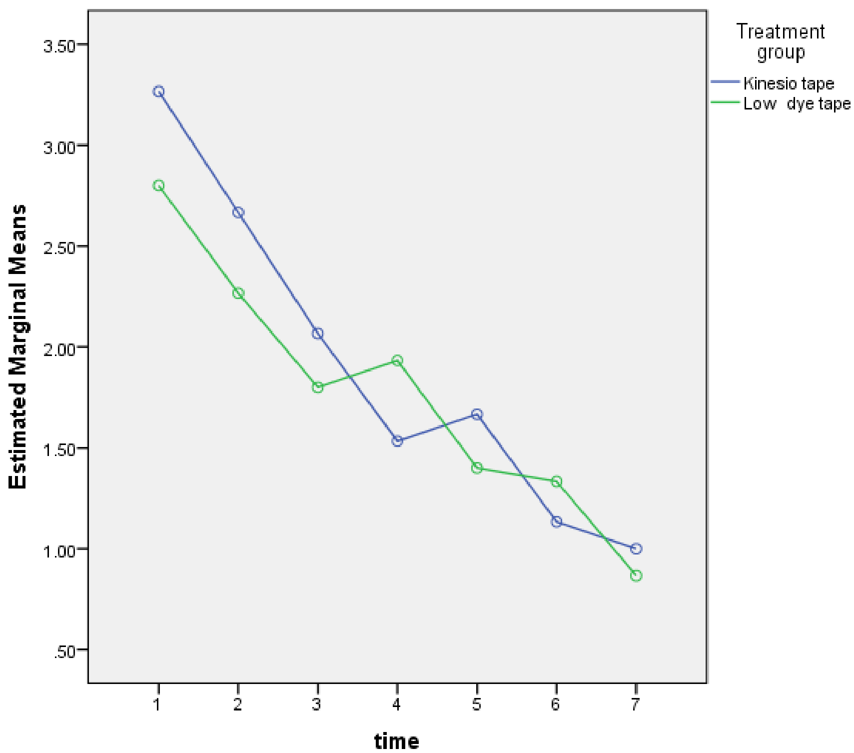

Figure 17: Profile plot of mean pain walking outside readings over time by group

Figure 17 shows both groups followed a similar almost parallel profile plot pattern over time. The steeper declining profile plot gradient of the Kinesio group, compared to the Low-Dye group, indicates the Kinesio group performed better at reducing pain on walking outside.

4.4.2.11 Pain climbing stairs

Table 26: Pain climbing stairs effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.253	< 0.001
Time x group	Wilk's lambda = 0.802	0.483
Group	F = 0.527	0.474

Table 26 shows there was a significant time effect ($p < 0.001$) showing that both groups decreased the value of pain on climbing stairs over time. There was no evidence of a differential treatment effect as the time x group effect was non-significant ($p = 0.483$).

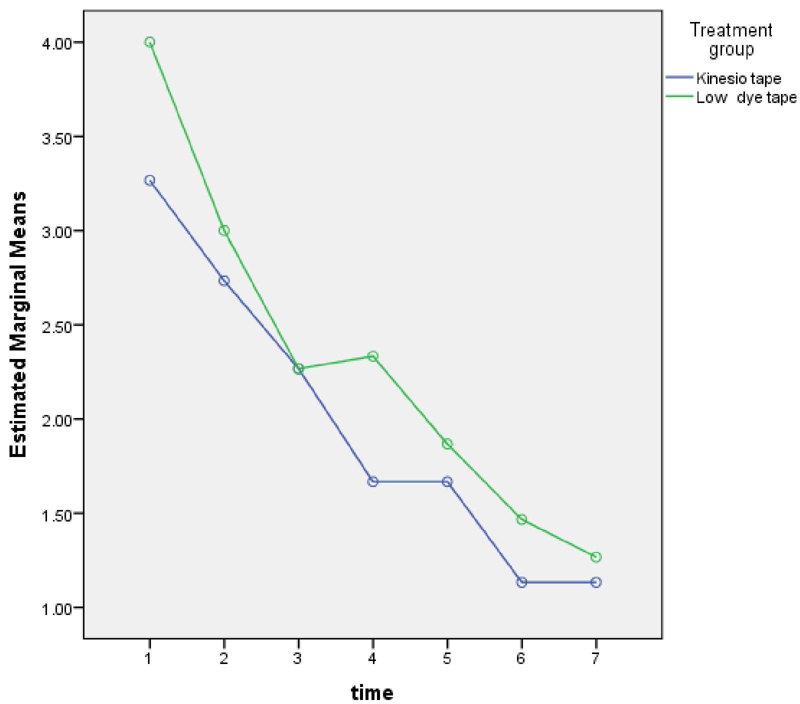

Figure 18: Profile plot of mean pain climbing stairs readings over time by group

Figure 18 shows that both groups improved at the same rate over time with nearly parallel profile plots. For both groups there is a marked decrease in pain climbing stairs between the Vists 1 and 2, after which there is a slight increase in the Low-Dye group followed by a steady decline. The Kinesio group follows a steady pattern of decline between Vists 1 and 4 after which it plateaud between Vists 4 and 5 then decreased from Visits 5 and 6 before levelling off again between Visits 6 and 7.

4.4.2.12 Pain descending stairs

Table 27: Pain descending stairs effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.313	< 0.001
Time x group	Wilk's lambda = 0.656	0.105
Group	F= 0.291	0.594

Table 27 shows a significant time effect ($p < 0.001$) indicating that both treatment groups reduced pain on descending stairs over time. There was no treatment effect as the time x group effect was non-significant ($p = 0.105$).

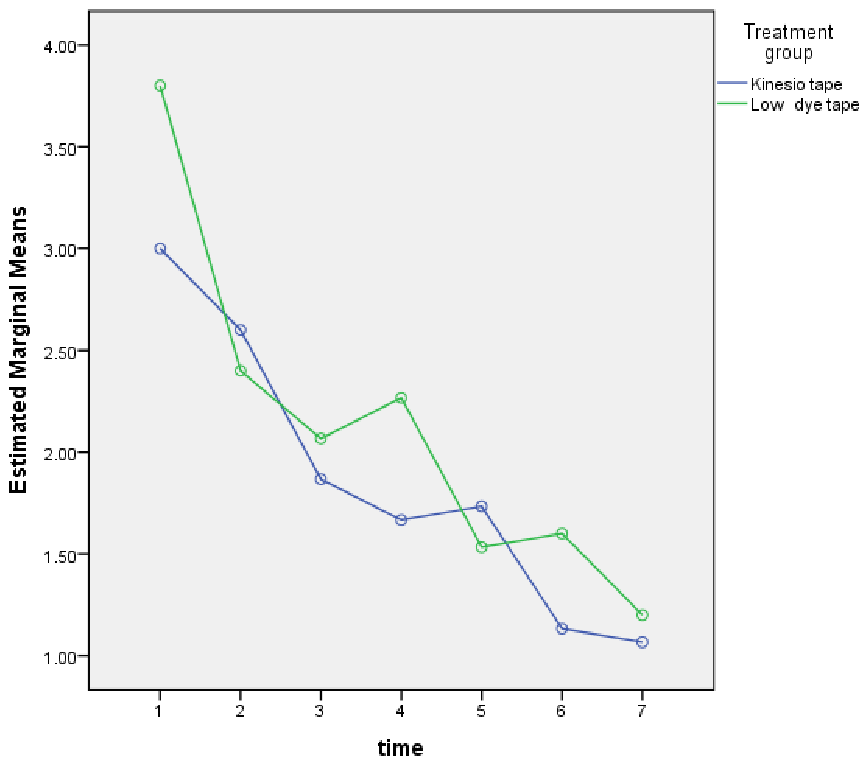

Figure 19: Profile plot of mean pain descending stairs readings over time by group

Figure 19 shows a steeper profile plot gradient for the Low-Dye group when compared to the Kinesio group profile plot gradient. The Low-Dye group also showed an increase in pain descending stairs between Visit 3 and 4, and Visits 5 and 6. The Kinesio group showed an increase in pain descending stairs between Visits 4 and 5.

4.4.2.13 Pain standing on tiptoe

Table 28: Pain standing on tiptoe effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.441	0.002
Time x group	Wilk's lambda = 0.820	0.552
Group	F = 0.542	0.468

Table 28 shows there was a significant time effect for pain standing on tiptoe (p = 0.002) which indicates that both groups decreased pain when standing on tiptoe over time. There was no significant treatment effect with the time x group effect being non-significant (p = 0.552).

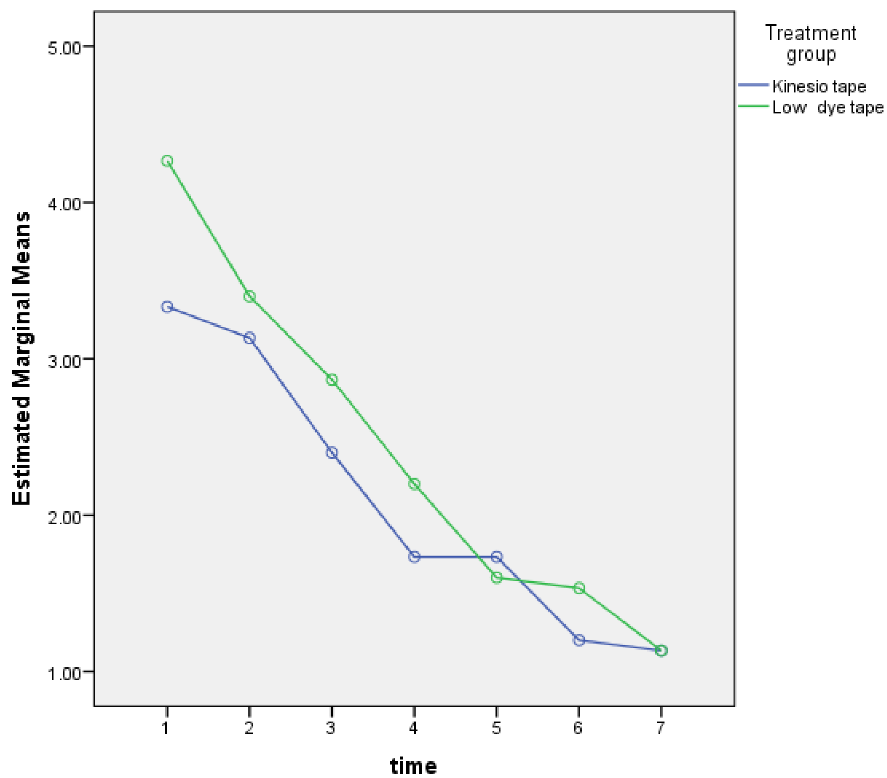

Figure 20: Profile plot of mean pain standing on tiptoe readings over time by group

Figure 20 shows the profile plot gradients of the two groups to be similar with the pain values of both decreasing over time. The readings at Visit 7 are identical.

4.4.2.14 Pain getting up from a chair

Table 29: Pain getting up from a chair effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.520	0.013
Time x group	Wilk's lambda = 0.671	0.127
Group	F = 0.000	0.987

Table 29 shows there was a significant time effect (p = 0.013) indicating that both groups decreased pain on getting up from a chair over time. There was no treatment effect as the time x group effect was non-significant(p = 0.127).

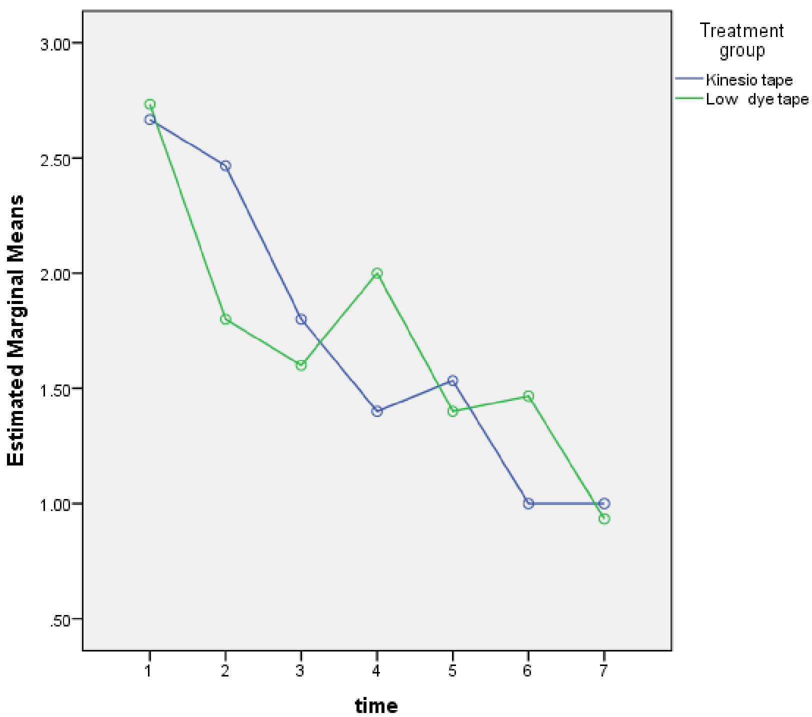

Figure 21: Profile plot of mean pain getting up from a chair readings over time by group

Figure 21 shows that the Low-Dye group had an increase in pain getting up from a chair between Visits 3 and 4 and Visits 5 and 6. The Kinesio tape group showed an increase in pain getting up from a chair between Visits 4 and 5. Both groups showed an overall reduction in pain getting up from a chair visible by the declining profile plot gradients of each, with nearly identical readings at Visit 7.

4.4.2.15 Pain climbing curbs

Table 30: Pain climbing curbs effects within and between groups

Effect	Statistic	P value
Time	Wilk's lambda = 0.451	0.003
Time x group	Wilk's lambda = 0.585	0.038
Group	F = 0.097	0.758

Table 30 shows there was a significant time effect on the pain climbing curbs (p = 0.003) indicating that both groups reduced the pain on climbing curbs over time. There was a significant differential effect of the treatment for pain climbing curbs (p = 0.038) with the Low-Dye group improving at a faster rate than the Kinesio group.

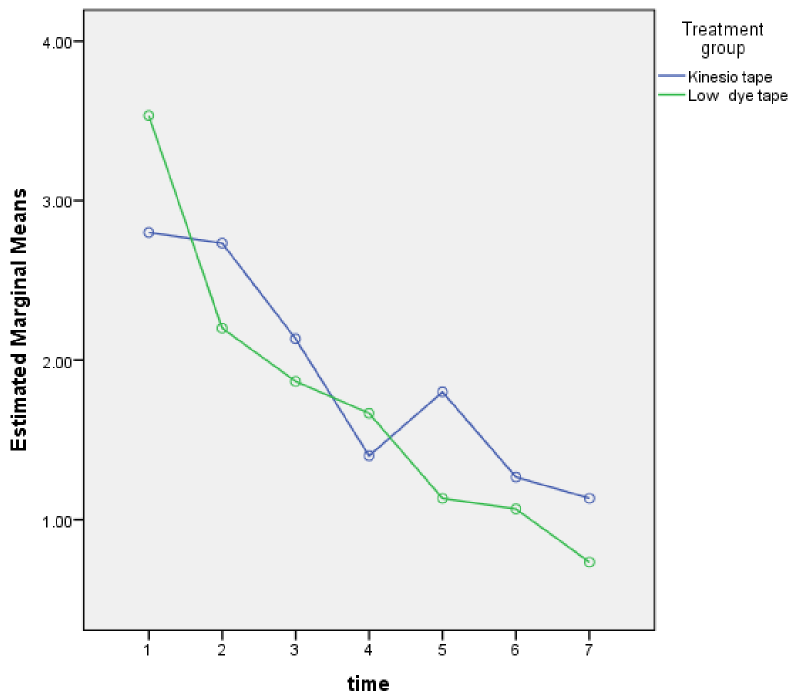

Figure 22: Profile plot of mean pain climbing curbs readings over time by group

Figure 22 shows the steeper profile plot gradient of the Low-Dye group indicating a faster rate of improvement in this group compared to the Kinesio group. The trend for both groups was a decrease in pain on climbing curbs however there was an increase in pain on climbing curbs in the Kinesio tape group between Visits 4 and 5.

4.4.2.16 Conclusion for FFI: Total Disability Score

All questions relating to FFI: Total Disability Score, except for pain getting up from a chair, showed a statistically significant reduction over time ($p \leq 0.005$). All disability scores showed a reduction in pain between Visit 1 and 7.There were two questions that showed a significant time by group treatment effect. For pain walking outside the Kinesio tape group showed a faster rate of improvement with a statistically significant time by group effect. For pain climbing curbs the Low-Dye group showed a faster rate of improvement with a statistically significant time by group effect. None of the other disability questions showed a time by group treatment effect. There were non-significant trends for the Low-Dye group to show better improvement than the Kinesio tape group for the FFI: Total Disability Score however no group was statistically superior to the other in the treatment of PF with regards to FFI: Total Disability Score.

4.4.2.17 Total Activity Limitation Score

The Activity Limitation Score of the FFI is made up of two questions: “Do you have to stay inside all day?” and “Do you have to stay in bed all day?” These are ‘yes’ and ‘no’ questions with the participant indicating one or the other when they full in the FFI at each visit.

Every participant, from both groups, at each visit indicated ‘no’ for both questions in the activity limitation section of the FFI. No statistical measures were needed as all participants indicated they had no activity limitation.

4.5 Comparison of objective and subjective results by group

Table 31: Comparison of results by group

	Treatment group				
	Kinesio tape		Low-Dye tape		P value
	Mean	Standard Deviation	Mean	Standard Deviation	
Objective measures					
Algometer	2.97	1.18	3.13	.97	0.688
Weight bearing ankle dorsiflexion (WBDF)	1.20	.22	1.07	.14	0.081
Subjective measures					
Visual analogue scale (VAS)	48.7	21.2	43.8	16.0	0.478
Worst pain	7.3	1.6	7.4	2.0	0.841
Morning pain	3.8	2.8	4.1	2.9	0.793
Pain walking barefoot	3.7	1.9	4.3	2.8	0.546
Pain walking with shoes	3.6	2.1	5.1	2.3	0.075
Pain standing with shoes	4.2	2.8	5.3	2.7	0.292
walk in the house	2.20	.50	2.67	.61	0.560
Walk outside	3.27	.59	2.80	.63	0.594
Climb stairs	3.27	.59	4.00	.62	0.400
Descend stairs	3.00	.58	3.80	.56	0.329
Stand on tip toe	3.33	.75	4.27	.64	0.352
Get up from a chair	2.67	.68	2.73	.70	0.946
Climb curbs	2.80	.70	3.53	.64	0.445

Table 31 shows that there were no significant baseline differences between the treatment groups in terms of objective measures and subjective measures.

4.6 Summary and conclusion

For almost all outcomes a significant change in a favourable direction was observed over time regardless of which treatment they received. For VAS there was statistical evidence of the Kinesio tape group improving better than the Low-Dye tape group. For pain walking outside, in the disability section of the FFI, there was statistical evidence of the Kinesio tape group improving more than the Low-Dye tape group. For morning pain, in the pain section of the FFI, and pain climbing curbs, in the disability section of the FFI, there was statistical evidence of the Low-Dye tape group improving more than the Kinesio tape group. For the other outcomes, there were non-significant trends towards the Low-Dye tape group showing better improvement than the Kinesio tape group. Therefore overall there is not enough evidence to conclude superiority of either of the treatments. Both treatments seemed to work equally well. The results will be discussed in detail in the next chapter.

CHAPTER 5: DISCUSSION

5.1 Introduction

In this chapter results from Chapter 4 will be discussed. The discussion will include demographic, objective and subjective data obtained from the study. The objective data consisted of the algometer, weight-bearing ankle dorsiflexion (WBDF) and ultrasonography data. The subjective data consisted of the VAS and the FFI. The initial part of the chapter will deal with analysis of the demographic data, with the latter part dealing with the objective and subjective analysis.

5.2 Demographics

5.2.1 Gender

The gender distribution of the sample of 30 participants (Table 3) showed a female predominance in the study with 70.0% of the total participants being female and 30.0% being male. Females make up the greater numbers in both treatment groups of the study (66.7% in the Kinesio tape group and 73.3% in the Low-Dye group). This is consistent with the female predominance of PF gender distribution found by Brown (1996) and Barrett and O'Malley (1999) and by the South African studies of Blake (2003), Du Plessis (2002), Hammond (2000) and Morris (2000) who all reported a slight female predominance. Women are affected by PF twice as much as men (Young, 2012) and the 70% female to 30 % male ratio found in this study supports this.

Although most studies have shown a female predominance of PF this isn't always the case. A study by Landorf and Menz (2007) showed a more equal distribution of gender while other studies have shown a male predominance, such as the study by Ambrosius and Kondracki (1992) and the South African studies by Dunn (2005) and Maartens (2005).

5.2.2 Race

The race distribution (Table 4) in this study showed 83.33% of participants to be White and 16.67% to be Indian. There were no Black or Coloured participants in this study. This ethnic distribution does not correlate with the demographics in KwaZulu Natal and the Ethekwini municipal region. The eThekwini Municipality (2011) states that the largest racial group in the municipal region of Ethekwini within KwaZulu Natal is Blacks (73.8%), followed by Indians (16.7%) and thirdly by Whites (6.6%). The study showed an inverse ethnic ratio which may be due to a number of reasons.

Maartens (2005) observed a similar race/ethnic distribution in her study with 63.9% White, 33.3% Indian and 2.8% Black/Coloured participants. As did Dunn (2005) in her study cohort with a 53.3% White, 43.3% Black and 3.3% Coloured distribution. Young (2012) states that race and ethnicity plays no role in the incidence of PF.

The racial profiling in the study is a limitation as it does not accurately reflect the demographics of the municipal region of the Ethekwini municipal region. The reason for the racial profile found in this study may be due to where the advertisements were placed; the advertisements for the research were placed around the DUT campus, sports clubs and local gyms which may not have the same race demographics as that of the municipal area at large which resulted in the sample acquired. Another contributing factor hypothesised by both Dunn (2005) and Maartens (2005) may be due to Chiropractic being derived from western culture and as such the Black population might have less exposure to it and not be as familiar with it being more exposed to traditional and allopathic medicine.

5.2.3 Age, weight, height and BMI

The study was limited to include participants between 20-45 years of age. Table 5 shows the oldest participant in the study was 41 years old, while the youngest participant was 20. In this study the average age was found to be 30.06 years. This is lower than other authors who found the average age to be slightly higher; for example the South African studies by Maartens (2005) was 36.67 years, Dunn (2005) 36 years, Blake (2003) 40.75 years, Morris (2000) 50.3 years and Hammond (2000) 40 years of age. However, both Toomey (2009) and Young et al. (2001) agree upon the 40-60 age bracket. Brown (1996) proposed the existence of two sub-groups of individuals more likely to suffer from PF; namely older individuals in the 40-60 age bracket and secondly younger athletic individuals. This study was conducted in individuals between the ages of 20-45 years of age, and as such more individuals from the younger athletic group of PF sufferers may have responded causing the younger mean age result. Also, the advertisements placed around a tertiary education, local gyms and running clubs frequented by a younger demographic may have added to the younger mean age in the study.

Table 5 shows the average weight was 74.613 kg, with the lowest measured at 43 kg and the highest at 148 kg. Using the participants mass and height their BMI was calculated. BMI is defined as a method of assessing nutritional status correlating with the risk of disease and death due to causes associated with obesity (Stedman, 2005). The average BMI of participants was found to be 26.1528, with values ranging from 18.61 to 48.88. Thus the majority of participants were found to fit into the overweight category according to BMI. This is congruent with McPoil et al (2008), Roxas (2005) and Young, Rutherford and Niedfeldt (2001) who found that obese individuals are more likely to suffer from PF.

Table 5 shows that the height of participants ranged from 1.52m to 1.91m, with a mean of 1.683m. No data was found relating height to suffering from PF but this was included to allow the BMI of participants to be calculated.

5.2.4 Occupation

The occupation of study participants (Table 6) revealed the highest proportion of participants with PF to be students (20.0%) with Chiropractors and candidate attorneys coming in joint second with 10% each. Numerous studies have shown that occupations that require standing and prolonged weight-bearing have a higher risk of developing PF, due to the repetitive tensile load placed on the plantar fascia (Young, 2012; Roxas, 2005; Brown, 1996). This might explain the higher incidence of PF in students, Chiropractors and candidate attorney as all of these occupations require standing and prolonged weight-bearing which can precipitate the development of PF.

Another reason for the high percentage of students could be due to the fact that the study was conducted at a tertiary education institution with advertisements placed around campus. The high percentage of Chiropractors may also be as a result of the study being conducted in a

Chiropractic Clinic that contains a large percentage of Chiropractors as lecturers, clinicians and patients.

5.2.5 Level of physical activity

The level of physical activity of participants (Table 7) revealed the highest proportion of participants to be recreational athletes (46.67%), followed by serious athletes (33.33%) and lastly non-athletes (20.0%). Fabrikant and Soon Park (2011) and Noakes (1985) agree that PF is especially common in runners and athletes affecting as many as 25% of athletes. The increased incidence in athletes and runners is thought to be due to repetitive stress and overuse that places excess strain in the plantar fascia (Young, Rutherford and Niedfeldt, 2001). PF can occur in non-athletes as well (Batt and Tanji, 1995) with up to 10% of sedentary individuals affected with PF (Ribeiro et al., 2011).

5.2.6 Shoes most commonly worn

The shoes most commonly worn by participants (Table 8) revealed the highest proportion of participants wear work shoes (70.0%), followed by slops (23.33%) and lastly high-heels (6.67%). The high proportion of those who wore work shoes most likely resulted from most of the participants taking time off work or coming straight after work for their consultation data readings and treatment.

Worn out shoes cause poor shock absorption and inadequate arch support to the foot while excessively flexible shoes allow greater toe flexion and increased tensile forces in the fascia (Rajput and Abboud, 2004). Both of these can place strain on the plantar fascia and may predispose to PF development. Young, Rutherford and Niedfeldt (2001) suggest replacing worn out shoes as this can help reduce PF symptoms. In this study degree of wear of the shoes was not taken into consideration only the category of footwear.

5.2.7 Sidedness of foot affected with PF

The sidedness of the foot affected with PF in participants (Table 9) revealed there was no significant difference in sidedness proportions with the right foot being affected in 17 (56.67%) of the participants, while the left foot was affected in 13 (43.33%). This is similar to the results in a study by Maartens (2005) who found a slight predominance (55.6%) of right feet affected compared to left feet affected (44.4%). In contrast Blake (2003) found left foot involvement 50% of the time, right foot involvement 37.5% of the time, and bilateral involvement in 12.5% of cases.

Based on laterality, 12 (40%) participants were noted as having bilateral foot involvement. This is in agreement with Young (2012) who stated that PF occurs bilaterally in a third of cases. For purposes of this study only the side affected worse was treated.

5.3 Objective clinical findings

5.3.1 Algometer

The statistical analysis of the algometer readings (Table 10) showed that both groups showed a statistically significant time effect (p = 0.002) with a mean increase in algometer measurements over the course of the study. This indicates both Kinesio Taping and Low-Dye taping were effective in reducing the pain pressure threshold in participants with PF over time. There was no significant time x group effect between the two groups for algometer measurements (p = 0.396) which indicates that neither treatment group showed a more significant benefit in increasing the pain pressure threshold as measured by the algometer.

The Kinesio group showed a faster and greater, although non-significant, improvement of algometer readings over time compared with the Low-Dye group. This may have been due to pain being neurologically suppressed by the therapeutic action of the Kinesio tape as well as the reduction of oedema, inflammation and swelling caused by the therapeutic application of the tape.

The Low-Dye tape group also experienced an overall improvement in algometer readings over time, but to a lesser extent than the Kinesio group. This improvement may be a result of the plantar fascia being allowed to heal naturally with the Low-Dye taping acting to prevent stretch and tensile forces passing through the damaged plantar fascia therefore allowing healing and increased ability to withstand pressure on the plantar fascia.

5.3.2 Weight bearing ankle dorsiflexion (WBDF)

Weight-bearing measurement of the ankle is a more functional measure than non-weight-bearing measurements (Jones et al., 2005). Weight-bearing ankle dorsiflexion has been shown to be a valid and reliable measure with a high inter-examiner and intra-examiner reliability in its use measuring weight-bearing ankle dorsiflexion in an injured population (Jones et al., 2005). One of the cardinal symptoms of PF is pain on foot dorsiflexion (Young, Rutherford and Niedfeldt, 2001; Barrett and O'Malley, 1999; Brantingham et al., 1992; Reid, 1992 and Noakes, 1985) thus dorsiflexion ability would increase should symptoms improve, and conversely decrease should symptoms worsen. Thus WBDF was used to determine the improvement or worsening of the symptoms of the participants' PF.

The statistical analysis of the weight bearing ankle dorsiflexion showed that there was no treatment effect between the two groups as the time x group effect was non-significant ($p = 0.212$) (Table 11). Figure 5 illustrates that the Kinesio taping group showed a decrease in WBDF measurement over time, indicating an increased range of ankle dorsiflexion, while the Low-Dye group showed a marginal increase in WBDF over time. Both groups had nearly identical readings at visit five, six and seven. The statistical analysis of weight-bearing dorsiflexion readings indicates that neither tape was more effective than the other in increasing the participants' dorsiflexion range of motion in participants with PF.

Although there was a non-significant treatment effect ($p = 0.212$) the trend was for the Kinesio tape group to have a larger effect on the WBDF readings between visits with the Kinesio group showing an overall decrease in mean WBDF. This indicates an increased ability to dorsiflex the ankle that shows increased flexibility. This may have been a result of the elastic properties of the tape that allow normal functioning of the plantar fascia while reducing oedema and inflammation by lifting the skin. It may also be due to the Kinesio tape's action on the plantar muscles and fascia itself helping return the function of the fascia and muscles to normal. This along with the neurological suppression of the pain by the tape may have allowed an increase in weight-bearing ankle dorsiflexion in the Kinesio tape group.

The Low-Dye group showed an overall increase in mean WBDF readings over time. This increase indicates reduced dorsiflexion ability of the ankle. This may be as a result of the Low-

Dye tape being of a rigid nature and not allowing stretch and normal functioning of the plantar fascia and foot musculature resulting in stiffness and reduced ability to dorsiflex the ankle.

5.3.3 Ultrasonography of the plantar fascia

There was a significant decrease in thickness of the plantar fascia in the affected foot in both treatment groups over time, the time effect was deemed to be statistically significant ($p < 0.001$). However, there was no time x group effect indicating no treatment effect of a statistical significance ($p = 0.116$) (Table 12). Figure 6 illustrating the profile of both groups shows that there was a trend for the Low-Dye group to show a faster rate of fascial thickness decrease and to a larger degree than the Kinesio tape group although this was not deemed to be of statistical significance ($p = 0.116$). Both groups showed a trend to reduce the thickness of the plantar fascia and if we look at the groups individually; at the initial visit, nine participants (60.0%) in the Kinesio group had thickening. This was reduced to five participants (33.33%) by the seventh visit – nearly half the original number. Similarly 11 participants (70.0%) had thickening in the Low-Dye group at Visit 1 and by Visit 7 this was down to just seven participants (46.67%). So both treatment interventions reduced the thickness of the plantar fascia in participants with PF.

The reduced thickness of the plantar fascia in the Kinesio tape group was most likely a result of a combination of two of the therapeutic effects proposed by Kase, Tatsuyuki and Tomoki (1993). The wave-like patterns on the tape lifting the skin to improve circulation of blood and lymphatics and reduce oedema and bleeding would result in a thinner plantar fascia. The tape would also have aided muscle function and relieved muscle tension to reduce the chance of re-injury.

Immobilisation by Low-Dye strapping shortens the distance between origin and insertion of the plantar musculature and fascia relieving the strain and tensile forces on weight bearing (Yale, 1987). In this way the strapping aims to allow healing to occur naturally (Hunt et al., 2004; Ambrosius and Kondracki, 1992). Thus mechanism of action of Low-Dye taping in the treatment of PF is achieved by decreasing stress and tensile force along the plantar plate protecting the plantar fascia.

As reported in Chapter 4, a total of four participants (13.33%) were found to have heel spurs on US examination. With heel spurs present in one of the participants (6.67%) in the Kinesio tape group and four of the participants (20.0%) in the Low-Dye taping group. This is slightly lower than expected when compared to both the general population and in PF suffers. Fifteen to twenty five percent of the asymptomatic general population has been shown to have heel spurs (Young, Rutherford and Niedfeldt, 2001) and up to 50% of patients with PF have heel spurs according to Cole, Seto and Gazewood (2005). The absence or presence of heel spurs is not helpful in diagnosing PF (Young, Rutherford and Niedfeldt, 2001).

5.4 Subjective clinical findings

5.4.1 Visual analogue scale (VAS)

The statistical analysis of the VAS showed that there was a significant time effect for both groups ($p < 0.001$) (Table 15) which means that both treatment groups were effective at reducing the mean VAS over the course of the study period. There was a statistically significant treatment effect showing that the Kinesio group improved better than the Low-Dye group ($p = 0.013$). Figure 7 shows the steady decline in VAS in both treatments over time. The Kinesio group showed a faster rate of decrease than the Low-Dye group. The Kinesio group also showed decreased VAS readings at each subsequent visit and even though it started at a higher average VAS, when compared to the Low-Dye group, it reduced the VAS to a greater extent overall when compared to the Low-Dye group. The Low-Dye group showed a less dramatic profile pattern with no change between Visits 1 and 2, a decrease between Visits 2 and 5 and 6 and 7, and an increase between Visits 5 and 6.

The Kinesio group may have been able to more effectively reduce the VAS of participants due to its stimulating effect on proprioceptive A-beta fibres which decrease the effect of nociceptive C fibres (Illes, 2009). The Low-Dye tape also reduced mean VAS readings in participants, although less effectively. This may have been accomplished by shortening the distance between origin and insertion of the plantar musculature and fascia which relieved the strain and tensile forces on weight bearing (Yale, 1987). In this way the strapping allowed healing to occur naturally (Hunt et al., 2004; Ambrosius and Kondracki, 1992) with the healing of the plantar fascia also being less painful.

5.4.2 The Foot Function Index (FFI)

5.4.2.1 FFI total score

There was a significant time effect ($p < 0.001$) (Table 16 indicating that both groups decreased the total FFI score over time. However the time x group effect indicating a treatment effect was non-significant ($p = 0.283$). Figure 8 shows that although both groups decrease the total FFI score the Low-Dye group has a steeper gradient and decreases FFI at a faster, although non statistically significant, rate than the Kinesio group. These findings suggest that both treatments may be effective in reducing the total FFI score because neither one was statistically superior to the other.

The statistical analysis of the Kinesio tape group showed there was a significant improvement in the FFI Total score over time. There was also a reduction in FFI Total score values at each visit. The overall decrease in FFI Total score for the Kinesio tape group may be a result of the reduction in oedema and inflammation due to the tape lifting the skin. The tape may have also aided the correct functioning of the plantar fascia and intrinsic foot muscles and neurologically suppressed the pain of the PF.

The statistical analysis of the Low-Dye group showed there was also a significant improvement in the participants' FFI Total score. The Low-Dye group improved the FFI Total score at every visit like the Kinesio tape group but it improved to a greater extent overall, although this was statistically non-significant. The reason for this improvement may have been due to the Low-Dye tape immobilising the plantar fascia and allowing healing. The rigid Low-Dye tape shortens the plantar fascia and does not allow stretch to occur; this allows healing with less chance of it being re-injured.

5.4.2.2 Total Pain Score

Total Pain Score for FFI incorporated the first five questions of the FFI. It includes: worst pain, morning pain, pain walking barefoot, pain walking with shoes and pain standing with shoes. There was a significant time effect for both treatment groups ($p < 0.001$) (Table 17) indicating that both groups reduced total pain score over time in the study. However there was a non-significant time x group treatment effect ($p = 0.076$). Figure 9 shows that the Low-Dye group reduced total pain score at a slightly quicker rate than the Kinesio group. At Visits 4, 5 and 6 the groups are nearly identical. These findings suggest that both treatment groups may be effective in reducing the total pain score in the FFI although neither was statistically superior to the other.

The statistical analysis of the Kinesio tape group showed that there was a reduction of participants' FFI Total Pain score over the duration of the study. At each visit there was a reduction in the FFI Total Pain score. This reduction in FFI Total Pain score may be a result of the Kinesio tape having a neurological suppression effect on the pain. The Kinesio tape may also have reduced the pain by reducing inflammation and oedema in the plantar fascia and allowing the foot muscles and plantar fascia itself to function correctly.

The statistical analysis of the Low-Dye group showed an overall reduction in the participants' FFI Total Pain score. There was a reduction in pain between all visits except between Visits 2 and 3. The overall reduction in the participants' FFI Total Pain Score may have been as a result of the Low-Dye taping supporting and protecting the damaged plantar fascia. In preventing excess stretch and tensile load to the plantar fascia the Low-Dye tape would allow healing to occur and thus a reduction in participants' pain.

5.4.2.3 Worst pain

Table 18 shows that the time effect for worst pain was statistically significant ($p < 0.001$) and that both groups reduced worst pain over time. There was no time x group treatment effect ($p = 0.560$). These findings suggest that both treatments may be effective in reducing participants' pain perception ($p < 0.001$) although no treatment was deemed to be superior to the other ($p = 0.560$).

The statistical analysis of the Kinesio taping group showed there was a significant improvement in participants' pain perception overall. Although the trend was for pain to decrease at all visits it increased between Visits 2 and 3 but then resumed the trend of decreasing at each visit. The reduction in pain for the Kinesio tape group may have been a result of neurological suppression; as the tape stimulates proprioceptive nerve fibres resulting in less pain. The tape may also have reduced oedema and thus inflammation by lifting the skin and promoting blood flow. The foot muscles and plantar fascia may also have been aided by the tape to function correctly.

The statistical analysis of the Low-Dye group showed that there was a significant improvement of participants' pain perception, with it decreasing at each subsequent visit. This reduction in pain may have been a result of the rigidity of the tape preventing tensile overload of the plantar fascia during activities thus limiting pain.

5.4.2.4 Morning pain

Table 19 shows that the time effect for morning pain was statistically significant ($p = 0.001$) and that both groups reduced morning pain over time. There was a significant differential effect in the treatment for morning pain ($p = 0.045$). The findings suggest that, although both treatments may be effective in reducing participants' worst pain over time, the Low-Dye group improved at a faster rate than the Kinesio group.

Morning pain is the most characteristic pain of PF, worst on the first few steps in the morning (Young, Rutherford and Niedfeldt, 2001). It is the result of stretching the contracted and damaged plantar fascia causing pain. The pain improves with further ambulation (Cole, Seto and Gazewood, 2005).

The Kinesio tape group decreased morning pain overall (Figure 11). This may be as a result of the tape being worn for up to three days over which time the tape could act on correcting intrinsic muscle imbalances in the foot, aiding the correct functioning of the fascia itself, reducing oedema and inflammation by stimulating blood circulation and neurologically stimulating the proprioceptive nerve fibres and reducing pain.

The Low-Dye group showed a faster, statistically significant, rate of improvement than the Kinesio tape group. This improvement may have been a result of the Low-Dye tape limiting the stretch of the plantar fascia on the first few steps in the morning. The Low-Dye tape is a rigid tape and as such would have provided structural support to the plantar fascia whilst also preventing stretching of the fascia; limiting pain in the mornings.

5.4.2.5 Pain walking barefoot

Table 20 shows that the time effect for pain walking barefoot was statistically significant ($p < 0.001$) and that both groups reduced pain walking barefoot over time. There was no time x group treatment effect ($p = 0.225$). The findings suggest both treatments may be effective in reducing participants' pain walking barefoot over time and that no treatment was superior to the other.

A greater strain is placed on the plantar fascia when walking barefoot as there is no shoe or orthotic to provide support (Cole, Seto and Gazewood, 2005). This increased strain on the plantar fascia can result in tensile overload and inflammation of the fascia (Batt and Tanji, 1995).

In aiding correct functioning of the foot muscles and plantar fascia itself the Kinesio group may have helped reduce pain on walking barefoot. Another possible explanation is the stimulation neurological suppression of pain fibres as the Kinesio tape would stimulate proprioceptive fibres. There may also have been a reduction in oedema and inflammation due to improved blood circulation.

The Low-Dye group decreased pain walking barefoot to a greater, although statistically non-significant, degree than the Kinesio group. This may be because the Low-Dye tape is more rigid in nature and would have supported the plantar fascia structurally while also limiting the amount of stretch in the fascia to reduce pain.

5.4.2.6 Pain walking with shoes

Table 21 shows that the time effect for pain walking with shoes was statistically significant ($p < 0.001$) and that both groups reduced pain walking with shoes over time. There was no time x group treatment effect ($p = 0.099$). The findings suggest both treatments may be effective in reducing participants' pain walking with shoes over time and that no treatment was superior to the other.

Walking with shoes would have provided some form of support to the plantar fascia, depending on the shoes. This support along with the added Kinesio tape may have helped reduce pain by aiding correct functioning of the plantar fascia and intrinsic foot muscles and by neurologically stimulating proprioceptive fibres suppressing pain fibres.

The Low-Dye group provided more support to the plantar fascia, which was already partially supported by the shoe itself. The rigid nature of the Low-Dye tape may have limited tensile forces and subsequent stretch of the plantar fascia to reduce pain.

5.4.2.7 Pain standing with shoes

Table 22 shows that the time effect for pain standing with shoes was statistically significant ($p < 0.001$) and that both groups reduced pain standing with shoes over time. There was no time x group treatment effect ($p = 0.088$). The findings suggest both treatments may be effective in reducing participants' pain standing with shoes over time and that no treatment was superior to the other.

Prolonged weight bearing such as standing can exacerbate the symptoms of PF (Young, Rutherford and Niedfeldt, 2001). This results from the increased tensile load placed on the damaged plantar fascia for a prolonged period.

The Kinesio tape may have helped reduce pain on standing by aiding and helping correct muscle function to ensure optimal performance. It may have also aided the damaged plantar fascia to help reduce pain on standing.

The Low-Dye tape may have helped reduce pain on standing by providing direct structural support to the plantar fascia limiting the amount of tensile force passing through it and preventing overload and strain to the fascia. The tape is rigid and would resist stretch to the plantar fascia by absorbing the force itself acting as a synthetic plantar fascia.

5.4.2.8 Total Disability score

The total disability score of the FFI includes seven questions relating to disability and pain. It includes results on pain and disability relating to walking in the house, walking outside, descending stairs, standing on tiptoe, getting up from a chair and climbing curbs.

The statistical analysis of the Total Disability score of the FFI showed a statistically significant time effect ($p < 0.001$) (Table 23). However, there was a non-significant time x group treatment effect ($p= 0.104$) which indicates that neither treatment was superior to the other in terms of reducing total disability score in the FFI. Figure 15 shows the overall trend of both groups to decrease total disability score in the FFI. These findings suggest that both treatments may have been effective in reducing the participants' total disability score in the FFI.

The statistical analysis of the Kinesio tape group for Total Disability score of the FFI showed an overall reduction in the FFI Total Disability score. This reduction may have resulted from the Kinesio tape allowing the correct functioning of the plantar fascia and intrinsic foot muscles while also reducing inflammation and oedema in the plantar fascia. This combination of effects may have facilitated a reduction in the Total Disability score of participants.

The statistical analysis of the Low-Dye group for Total Disability score of the FFI showed an overall reduction in readings for the FFI Total Disability score. This reduction may be a result of the Low-Dye tape, with its rigid properties, supporting and preventing strain of the plantar fascia to allow healing and reduce disability.

5.4.2.9 Pain walking in the house

Table 24 shows that the time effect for pain walking inside was nearly statistically significant ($p = 0.005$) and that both groups reduced pain on walking in the house over time. There was no time x group treatment effect ($p = 0.134$).

Both the Kinesio tape group and the Low-Dye tape reduced the pain on walking in the house score. There was no significant difference in treatment effect between the two groups and neither was statistically superior to the other. The Kinesio tape group may have helped reduce the pain on walking in the house by reducing oedema, stimulating proprioceptive A-fibres which would inhibit the nociceptive C-fibres that carry pain impulses. Low-Dye tape would reduce pain by preventing the plantar fascia from stretching as it shortens the plantar fascia to allow healing.

5.4.2.10 Pain walking outside

Table 25 shows that the time effect for pain walking outside was statistically significant ($p = 0.002$) indicating both groups were effective at decreasing participants pain on walking outside over the course of the study. There was a significant differential effect of the treatment for pain walking outside (p = 0.046) with the Kinesio group improving at a faster rate than the Low-Dye group.

Walking outside would include walking on uneven surfaces including bumpy, irregular surfaces requiring greater flexibility from the plantar fascia as the foot has to conform and adapt to the changing surfaces as opposed to smooth regular surface (such as those found indoors) (Dunn, 2005). Both the Kinesio and Low-Dye groups reduced pain on walking outdoors. For the Kinesio group the pain may have been reduced at a faster rate due to the reduction of inflammation in the plantar fascia, the neurological suppression of pain due to the stimulation of the proprioceptive A-fibres and the tape aiding the correct functioning of the plantar fascia. The Low-Dye tape would provide a more structurally supportive roll and limit stretch of the plantar fascia and in this way reduce pain on walking outside.

5.4.2.11 Pain climbing stairs

Table 26 shows that the time effect for pain climbing stairs was statistically significant (p < 0.001) indicating that both treatments were effective in reducing pain on climbing stairs over the course of the study. There was no time x group treatment effect (p = 0.474).

Climbing stairs would place increased tensile forces on both the plantar fascia and the triceps surae muscles. Both groups significantly reduced pain on climbing stairs as per Figure 17 The Kinesio group would do so by reducing inflammation, neurological suppression of nociceptive fibres and by aiding the correct functioning of the plantar fascia. This would have helped to reduce the pain. For the Low-Dye group the rigid tape would limit the stretch of the plantar fascia due to its rigidity thus preventing excessive tensile forces on the fascia and therefore limiting pain.

5.4.2.12 Pain descending stairs

Table 27 shows that the time effect for pain descending stairs was statistically significant (p < 0.001) indicating that both groups were effective at reducing pain on descending stairs over the course of the study. There was no treatment effect as the time x group effect was non-significant(p = 0.105).

Descending stairs requires absorption of large forces due to eccentric muscle action in order to slow the body down. The plantar fascia would be placed under large stresses as descending stairs would put the plantar fascia under a great amount of tension. The Kinesio tape, being elastic in nature would help absorb some of these forces reducing the load on the plantar fascia. It would also aid the fascia in functioning correctly and reduce potential muscle tension to reduce overall pain on descending stairs. The Low-Dye tape would again limit the stretch of the plantar fascia therefore limiting the size of the tensile forces placed on it to help limit pain on descending stairs. The Low-Dye may have reduced pain more (Figure 19) on descending stairs due to its more structurally supportive nature. However this was deemed to be statistically non-significant.

5.4.2.13 Pain standing on tiptoe

Table 28 shows the time effect for pain standing on tiptoe was statistically significant ($p = 0.002$) indicating both groups were effective at reducing pain on standing on tip toe over the course of the treatment. There was no treatment effect as the time x group effect was non-significant ($p = 0.468$).

Standing on tiptoe is known to aggravate the pain of PF (Young, Rutherford and Niedfeldt, 2001) as this position stretches the plantar fascia to cause pain. The pain for standing on tip toe in the Kinesio tape group may have been decreased by the tapes effect at neurologically suppressing pain impulses by stimulating proprioceptive fibres. However it is more likely the pain was reduced by correcting muscle function in the foot and the assisting the correct functioning of the plantar fascia. The Low-Dye tape may have reduced pain by limiting stretch of the plantar fascia itself by shortening the distance from the fascia’s origin to insertion due to the taping application.

5.4.2.14 Pain getting up from chair

Table 29 shows the time effect for getting up from a chair was statistically significant ($p = 0.013$) indicating that both groups were effective at reducing pain on getting up from a chair over the course of the study. There was no treatment effect as the time x group effect was non-significant($p = 0.127$).

The pain of PF is characteristically worse after prolonged inactivity (Young, Rutherford and Niedfeldt, 2001) such as sitting. This is related to the stiffening and contracture of the plantar fascia that occurs during inactivity (Batt and Tanji, 1995). The Kinesio group may have reduced pain on getting up from a chair due to neurologically suppressing the pain by stimulating the proprioceptive fibres or by facilitating the correct functioning of the foot muscles and plantar fascia to limit the pain on getting up from a chair. The Low-Dye tape may have reduced pain by limiting the stretching of the plantar fascia on getting up from a chair as it is rigid in nature and its application limits the plantar fascia from stretching and creating microtears.

5.4.2.15 Pain climbing curbs

Table 30 shows the time effect for climbing curbs was statistically significant ($p = 0.003$) indicating that both groups were effective at reducing pain on climbing curbs over the course of the study. There was a significant differential effect of the treatment for pain climbing curbs ($p = 0.038$) with the Low-Dye group improving at a faster rate than the Kinesio group.

The Kinesio group may reduce pain on climbing curbs by reducing inflammation, neurological suppression of nociceptive fibres and by aiding the correct functioning of the plantar fascia. This would have helped to reduce the pain. The faster improvement for the Low-Dye group may have been due to the rigid tape limiting the stretch of the plantar fascia due to its rigidity thus preventing excessive tensile forces on the fascia and therefore limiting pain.

5.4.2.16 Total Activity Limitation score

The Total Activity Limitation section of the FFI was not analysed for statistical significance as every participant answered ‘no’ to the two questions on activity limitation; “Do you have to stay inside all day?” and “Do you have to stay in bed all day?”, and as such no analysis could be done.

The reason for this could be due to the fact that the participants presenting to the DUT Chiropractic Day Clinic were in the lower to middle end of the PF pain spectrum. With more serious cases presenting to hospitals, General Practitioners and orthopaedic surgeons instead.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter will discuss the outcomes of this research based on the objectives. It will also make recommendations with regards to further research.

6.2 Conclusion

The aim of this study was to investigate the effectiveness of two different taping techniques in the treatment of plantar fasciitis. After statistical analysis of the objective and subjective data the study found that both treatments were effective in the treatment of PF with neither showing superiority to the other.

6.2.1 In terms of objective data

Objective One was to determine the effectiveness of Kinesio taping versus Low-Dye taping in participants with PF in terms of objective measurements (algometer, weight-bearing ankle dorsiflexion and ultrasonography). In terms of objective data a significant change in a favourable direction was observed over time for all measures, regardless of which treatment they received. There was no treatment effect for any of the objective measures with no treatment group statistically superior to the other. However there was a non-significant trend towards the Low-Dye tape group showing better improvement than the Kinesio tape group for the ultrasonography measure of plantar fascia thickness pre- and post-treatment.

6.2.2 In terms of subjective data

Objective Two was to determine the effectiveness of Kinesio taping versus Low-Dye taping in participants with PF in terms of subjective measurements (VAS and FFI). In terms of subjective data a significant change in a favourable direction was observed over time for all measures, regardless of which treatment they received. For VAS there was statistical evidence of the Kinesio tape group improving better than the Low-Dye tape group. For morning pain in the pain section of the FFI there was statistical evidence of the Low-Dye tape group improving better than the Kinesio tape group. In the disability section of the FFI there was statistical evidence of the Kinesio tape group improving better than the Low-Dye tape group for pain walking outside and the Low-Dye tape group improving better than the Kinesio tape group for pain climbing curbs. For the other outcomes, there were non-significant trends towards the Low-Dye tape group showing better improvement than the Kinesio tape group.

6.2.3 In terms of correlation

Objective Three was to compare the effectiveness of Kinesio taping versus Low-Dye taping in terms of objective measurements and subjective measurements in participants with PF.

For both objective and subjective data there was a significant change in a favourable direction observed over time for all measures, regardless of which treatment they received. The objective measures showed that there was no treatment effect for any of the measures, and no treatment group proved to be statistically superior to the other. Although there was a non-significant trend towards the Low-Dye tape group showing better improvement than the Kinesio tape group for the plantar fascia thickness on ultrasonography pre- and post-treatment.

For the subjective data measures using the VAS there was statistical evidence of the Kinesio tape group improving better than the Low-Dye tape group. For morning pain and pain climbing curbs in the FFI there was statistical evidence of the Low-Dye tape group improving better than the Kinesio tape group. For pain walking outside in the FFI there was statistical evidence of the Kinesio tape group improving better than the Low-Dye group. For all the other subjective outcomes, there were non-significant trends towards the Low-Dye tape group showing better improvement than the Kinesio tape group

In conclusion, in studying the effectiveness of Kinesio taping versus Low-Dye taping in the treatment of PF no treatment was found to be significantly statistically superior to the other. Both proved to be effective in the treatment of PF and neither of the treatments proved to be superior to the other. Both Kinesio tape and Low-Dye tape can effectively be used by practitioners to treat individuals suffering from PF.

6.3 Recommendations

The following recommendations are made for future studies based on this research study:

- Collecting data from a more homogenous age strata. The literature on PF shows that the condition affects two age groups; younger athletes and older individuals. Ideally, two separate studies, one on younger and one on older individuals would be beneficial. PF is commonly found in older individuals (50+) many respondents were too old to be included in the study. The disadvantage of increasing the age limit is that older individuals suffer from a wider variety of conditions that may cause foot pain and present similar to PF.

- A larger sample size of specific strata (age, level of physical activity or occupation). The homogeneity of the cohort will enable stronger findings and conclusions. This study was limited to 30 participants due to time and financial restraints. The use of a statistical analysis package did yield statistically significant results for the study, however; a larger more stratified sample size would strengthen the validity of the study with more statistical significant results.

- Collecting data from a racial profile that more accurately represents the population being investigated. A racial profile similar to that of the area of study will enable stronger findings, strengthen the validity of the study and allow more statistically significant results and conclusions to be drawn and extrapolated to the greater population.

- The addition of a third and possibly a fourth treatment group. Another treatment group should be added testing the effectiveness of a combination of both types of taping on PF. Another possible treatment group could be included which would alternate between the two different taping methods between each consultation. The two different therapeutic effects of the taping could have a cumulative effect on PF treatment. A placebo group could also be added to rule out the possible effect from placebo treatment.

- The use of double blinding. In future studies an additional clinician could be used to take only the objective and subjective measurements. Double blinding would strengthen the validity of the results adding greater statistical significance.

- The use of a more specific questionnaire. The FFI was used in this study as a subjective measure of pain, disability and activity limitation in participants. The FFI was initially developed for use in rheumatoid arthritis patients and is not specific for PF, although it has been commonly used in PF studies. The use of a more specific questionnaire may yield more statistically relevant results.

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APPENDIX A

Heel or foot arch pain?

Are you aged between 20-45?

You may qualify for research being conducted at Durban University of Technology

CHIROPRACTIC DAY CLINIC

WHICH INCLUDES:

Treatment available to those who qualify to take part in this study

For more information contact:

Justin

on

(031) 373 2205 / 084 760 9244

APPENDIX B

Letter of information and consent

Dear Participant, welcome to my research project and thank you for taking the time to consider participating.

Title of Research Study:
An investigation into the relative effectiveness of two different taping techniques in the treatment of plantar fasciitis.

Principle Investigator:
Justin Petzer Contact number: (031) 373 2205 / 084 760 9244
Co-Investigator:
Supervisor
Dr Grant Matkovich Contact number: 0825683986

Brief Introduction and Purpose of the Study:
The purpose of this study will be to determine the relative effectiveness of two different taping methods in the treatment of plantar fasciitis, a common cause of foot pain in both athletes and non-athletes. Low-dye taping is the more recognized form of taping compared to the newer Kinesio taping method.

Outline of the Procedures:
Forty volunteers will be required to complete this study (20 in each of two groups). At the initial consultation you will be screened for suitability against preset criteria. In order to do this, you will undergo a case history, physical examination and foot and ankle regional examination. Clinical measurements will then be taken and you will be sent for a diagnostic ultrasound of your plantar fascia (bottom of your foot) before we commence treatment. Treatment will depend on which group you are in. This will be randomly done by someone other than myself, so that neither of us know which treatment you are getting until we need to treat you. Both groups will receive the same number of treatments with a beneficial form of taping, one with Low-dye taping and the other with Kinesio Taping. A total of 6 treatments will take place over a period of 3 weeks. A second ultrasound evaluation will take place at the follow up visit in week 4 of the research period.

Risks or Discomforts to the Subject:
There are no major risks involved with either Low-dye or Kinesio Taping. Minor things you may experience include transient foot pain, discomfort, tenderness and / or itchiness. There is a small chance that you may react to the tape adhesive in the form of an allergic reaction (this however is rare). Therefore it is important that you report any allergy that you might have. All these effects are temporary in nature. There may be no improvement in pain or participant symptoms.

Benefits:
The benefits outweigh the risks. You are eligible for treatment for your plantar fasciitis (as per this study) and based on the hypothesis of the study you are expected to benefit from either intervention. Decreased treatment time is also expected due to faster improvement.

Reason/s why the Subject May Be Withdrawn from the Study:
You are free to withdraw from this study at any stage, without giving reasons for doing so and you shall not suffer any adverse consequences.
If you do not meet the inclusion criteria will not be admitted into the research. If you are found to have been dishonest in the history provided and / or fail to comply with the treatment protocol and follow up consultations you will be excluded from the study.

Remuneration:
You will NOT receive a travel allowance or any remuneration for participating in the study. However you will, as a participant in the study, not be charged for your consultations, as long as the consultations are within the parameters of the study. Based on the hypothesis of the study patients are expected to benefit from either interventions.

Costs of the Study:
You will not be expected to contribute towards any costs involved in the research process, as all consultations within the parameters of the study are free. However you will be required to pay for your own transport costs to and from the Chiropractic Day Clinic.

Confidentiality:
All patient information is confidential and will be kept in a patient file at the Chiropractic Day Clinic for fifteen years after which all research information will be destroyed. The results from this study will be used for research purposes only and will be made available in the Durban University of Technology Library in the form of a mini-dissertation.

Persons to Contact in the Event of Any Problems or Queries:
Researcher: Justin Petzer (031 373 2205 / 084 760 9244)
Supervisor: Dr Grant Matkovich (0825683986)
IREC Administrator : 031 3732900

Statement of Agreement to Participate in the Research Study:

(I,………………………………………………………….(subject's full name), ……………………………….(ID number), have read this document in its entirety and understand its contents. Where I have had any questions or queries, these have been explained to me by …….to my satisfaction. Furthermore, I fully understand that I may withdraw from this study at any stage without any adverse consequences and my future health care will not be compromised. I, therefore, voluntarily agree to participate in this study.

Subject's name (print) ……………………………………….…
Subject's signature:…………………………..…….. Date:……………..…

Researcher's name (print) signature: …………………..………...
Researcher's signature:…………….. Date:......................

Witness name (print) signature: …………………………...
Witness signature:…………...................... Date:………………….
Your participation in this study is greatly appreciated.

Yours faithfully
Research Student: _______________ Date: _______________

APPENDIX C

DURBAN UNIVERSITY OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC

Patient: ____ Date: _________

File #: ______________________ Age:___________

Sex: _________ Occupation: ____

Intern:___________________________________ Signature:__________________________________

FOR CLINICIANS USE ONLY:
Initial visit
Clinician: Signature :

Case History:

Examination:
Previous: Current:

X-Ray Studies:
Previous: Current:

Clinical Path. lab:
Previous: Current:

CASE STATUS:

PTT:	Signature:	Date:

CONDITIONAL: Reason for Conditional:	
Signature:	Date:

Conditions met in Visit No:	Signed into PTT:	Date:

Case Summary signed off:	Date:

<u>Intern's Case History:</u>

1. Source of History:

2. Chief Complaint : (patient's own words):

3. Present Illness:

	Complaint 1	**Complaint 2**
< Location		
< Onset : Initial:		
Recent:		
< Cause:		
< Duration		
< Frequency		
< Pain (Character)		
< Progression		
< Aggravating Factors		
< Relieving Factors		
< Associated S & S		
< Previous Occurrences		
< Past Treatment		
< Outcome:		

4. Other Complaints:

5. Past Medical History:

< General Health Status

< Childhood Illnesses

< Adult Illnesses

< Psychiatric Illnesses

< Accidents/Injuries

< Surgery

< Hospitalizations

6. Current health status and life-style:

< Allergies

< Immunizations

< Screening Tests incl. x-rays

< Environmental Hazards (Home, School, Work)

< Exercise and Leisure

< Sleep Patterns

< Diet

< Current Medication
Analgesics/week:

< Tobacco

< Alcohol

< Social Drugs

7. Immediate Family Medical History:

< Age
< Health
< Cause of Death
< DM
< Heart Disease
< TB
< Stroke
< Kidney Disease
< CA
< Arthritis
< Anaemia
< Headaches
< Thyroid Disease
< Epilepsy
< Mental Illness
< Alcoholism
< Drug Addiction
< Other

8. Psychosocial history:

< Home Situation and daily life
< Important experiences
< Religious Beliefs

9. Review of Systems:

< General

< Skin

< Head

< Eyes

< Ears

< Nose/Sinuses

< Mouth/Throat

< Neck

< Breasts

< Respiratory

< Cardiac

< Gastro-intestinal

< Urinary

< Genital

< Vascular

< Musculoskeletal

< Neurologic

< Haematologic

< Endocrine

< Psychiatric

APPENDIX D

DURBAN UNIVERSITY OF TECHNOLOGY
CHIROPRACTIC DAY CLINIC
PHYSICAL EXAMINATION

Patient:____File#:___________Date: ______

Clinician:______________________________Signature:_____________________________________

Student:_______________________________Signature:__________________________________

1. VITALS

Pulse rate:
Respiratory rate:
Blood pressure: R L Medication if hypertensive:
Temperature:
Height:
Weight: Any change Y/N If Yes : how much gain/loss
Over what period

2. GENERAL EXAMINATION

General Impression:
Skin:
Jaundice:
Pallor:
Clubbing:
Cyanosis (Central/Peripheral):
Oedema:
Lymph nodes - Head and neck:
- Axillary:
- Epitrochlear:
- Inguinal:

Urinalysis:

3. CARDIOVASCULAR EXAMINATION

1) Is this patient in **Cardiac Failure** ?
2) Does this patient have signs of **Infective Endocarditis** ?
3) Does this patient have **Rheumatic Heart Disease ?**

Inspection
- Scars
- Chest deformity:
- Precordial bulge:
- Neck -JVP:

Palpation:
- Apex Beat (character + location):
- Right or left ventricular heave:
- Epigastric Pulsations:
- Palpable P2:
- Palpable A2:

Pulses: - General Impression: - Dorsalis pedis:
- Radio-femoral delay: -Posterior tibial:
- Carotid: - Popliteal:
- Radial: - Femoral:

Percussion: - borders of heart

Auscultation:- heart valves (mitral, aortic, tricuspid, pulmonary)
- Murmurs (timing,systolic/diastolic, site, radiation, grade).

4. RESPIRATORY EXAMINATION

1) Is this patient in **Respiratory Distress** ?

Inspection
- Barrel chest:
- Pectus carinatum/cavinatum:
- Left precordial bulge:
- Symmetry of movement:
- Scars:

Palpation
- Tracheal symmetry:
- Tracheal tug:
- Thyroid Gland:
- Symmetry of movement (ant + post)
- Tactile fremitus:

Percussion
- Percussion note:
- Cardiac dullness:
- Liver dullness:

Auscultation
- Normal breath sounds bilat.:
- Adventitious sounds (crackles, wheezes, crepitations)
- Pleural frictional rub:
- Vocal resonance
  - Whispering pectoriloquy:
  - Bronchophony:
  - Egophony:

5. ABDOMINAL EXAMINATION

1) Is this patient in **Liver Failure** ?

Inspection
- Shape:
- Scars:
- Hernias:

Palpation
- Superficial:
- Deep = Organomegally:
- Masses (intra- or extramural)
- Aorta:

Percussion
- Rebound tenderness:
- Ascites:
- Masses:

Auscultation
- Bowel sounds:
- Arteries (aortic, renal, iliac, femoral, hepatic)

Rectal Examination - Perianal skin:
- Sphincter tone & S4 Dermatome:
- Obvious masses:
- Prostate:
- Appendix:

6. G.U.T EXAMINATION

External genitalia**:**
Hernias:
Masses:
Discharges:

7. NEUROLOGICAL EXAMINATION

Gait and Posture
- Abnormalities in gait:
- Walking on heels (L4-L5):
- Walking on toes (S1-S2):
- Rombergs test (Pronator Drift):

Higher Mental Function
- Information and Vocabulary:
- Calculating ability:
- Abstract Thinking:

G.C.S.:
- Eyes:
- Motor:
- Verbal:

Evidence of head trauma:

Evidence of Meningism:
- Neck mobility and Brudzinski's sign:
- Kernigs sign:

Cranial Nerves:

I Any loss of smell/taste:
Nose examination:

II External examination of eye:
- Visual Acuity:
- Visual fields by confrontation:
- Pupillary light reflexes = Direct:
  = Consensual:
- Fundoscopy findings:

III Ocular Muscles:
Eye opening strength:

IV Inferior and Medial movement of eye:

V
a. Sensory
- Ophthalmic:
- Maxillary:
- Mandibular:

b. Motor
- Masseter:
- Jaw lateral movement:

c. Reflexes
- Corneal reflex
- Jaw jerk

VI Lateral movement of eyes

VII a. Motor - Raise eyebrows:
- Frown:
- Close eyes against resistance:
- Show teeth:
- Blow out cheeks:

b. Taste - Anterior two-thirds of tongue:

VIII General Hearing:
Rinnes = L: R:
Webers lateralisation:
Vestibular function - Nystagmus:
- Rombergs:
- Wallenbergs:

Otoscope examination:

IX & X Gag reflex:
Uvula deviation:
Speech quality:

XI Shoulder lift:
S.C.M. strength:

XII Inspection of tongue (deviation):

Motor System:

a. Power
- Shoulder = Abduction & Adduction:
  = Flexion & Extension:
- Elbow = Flexion & Extension:
- Wrist = Flexion & Extension:
- Forearm = Supination & Pronation:
- Fingers = Extension (Interphalangeals & M.C.P's):
- Thumb = Opposition:
- Hip = Flexion & Extension:
  = Adduction & Abduction:
- Knee = Flexion & Extension:
- Foot = Dorsiflexion & Plantar flexion:
  = Inversion & Eversion:
  = Toe (Plantarflexion & Dorsiflexion):

b. Tone - Shoulder:
- Elbow:
- Wrist:
- Lower limb - Int. & Ext. rotation:
- Knee clonus:
- ankle clonus:

c. Reflexes - Biceps:
- Triceps:
- Supinator:
- Knee:
- Ankle:
- Abdominal:
- Plantar:

Sensory System:

a. Dermatomes
- Light touch:
- Crude touch:
- Pain:
- Temperature:
- Two point discrimination:

b. Joint position sense
- Finger:
- Toe:

c. Vibration:
- Big toe:
- Tibial tuberosity:
- ASIS:
- Interphalangeal Joint:
- Sternum:

Cerebellar function:

Obvious signs of cerebellar dysfunction:
= Intention Tremor:
= Nystagmus:
= Truncal Ataxia:
Finger-nose test (Dysmetria):
Rapid alternating movements (Dysdiadochokinesia):
Heel-shin test:
Heel-toe gait:
Reflexes:
Signs of Parkinsons:

8. SPINAL EXAMINATION:(See Regional examination)

Obvious Abnormalities:
Spinous Percussion:
R.O.M:
Other:

9. BREAST EXAMINATION:

Summon female chaperon.

Inspection
- Hands rested in lap:
- Hands pressed on hips:
- Arms above head:
- Leaning forward:

Palpation
- masses:
- tenderness:
- axillary tail:
- nipple:
- regional lymph nodes:

APPENDIX E

DURBAN UNIVERSITY of TECHNOLOGY
Making Knowledge Useful

Foot and ankle regional examination

Patient:______________________________File no:_______________Date:__________

Intern / Resident____________________Signature:________________________________

Clinician:________________________Signature:________________________________

Observation

Gait analysis (antalgic limp,toe off, arch, foot alignment, tibial alignment)._

____

Swelling____

Heloma dura / molle____

Skin____

Nails____

Shoes____

Contours (achilles tendon, bony prominences)_________________________________

Active movements

Weight bearing:	**R**	**L**	***Non weight bearing:***	**R**	**L**
Plantar flexion			50°		
Dorsiflexion			20°		
Supination					
Pronation					
Toe dorsiflexion			40°(mtp)		
Toe plantar flexion			40° (mtp)		
		Big toe dorsiflexion (mtp) (65-70°)			
		Big toe plantar flexion (mtp) 45°			
		Toe abduction + adduction			
		5° first ray dorsiflexion			
		5° first ray plantar flexion			

Passive movement motion palpation (Passive ROM quality, ROM overpressure, joint play)

	R	**L**		**R**	**L**
Ankle joint: *Plantarflexion*			Subtalar joint: *Varus*		
Dorsiflexion			*Valgus*		
Talocrural: *Long axis distraction*			Midtarsal:*A-P glide*		
First ray: *Dorsiflexion*			*P-A glide*		
Plantarflexion			*rotation*		
Circumduction of forefoot on fixed rearfoot			Intermetatarsal glide		
			Tarso metatarsal joints: *A-P*		
Interphalangeal joints: *L/A dist*			Metatarsophalangeal dorsiflexion (with associated plantar flexion of each toe		
A-P glide					
lat and med glide					
rotation					

Resistened Isometric movements

	R	L		R	L
Knee flexion			Pronation (eversion)		
Plantar flexion			Toe extension (dorsiflexion)		
Dorsiflexion			Toe flexion (plantar flexion)		
Supination (inversion)					

Neurological

	R	L
Dermatomes		
Myotomes		
Reflexes		
Balance/proprioception		

Special tests

	R	L
Anterior drawer test		
Talar tilt		
Thompson test		
Homan sign		
Tinel's sign		
Test for rigid/flexible flatfoot		
Kleiger test (med. deltoid)		

Alignment

	R	L
Heel to ground		
Feiss line		
Tibial torsion		
Heel to leg (subtalar neutral)		
Subtalar neutral position:		
Forefoot to heel (subtalar & Midtarsal neutral)		
First ray alignment		
Digital deformities		
Digital deformity flexible		

Palpation

Anteriorly

	R	L
Medial maleoli		
Med tarsal bones, tibial (post) artery		
Lat.malleolous, calcaneus, sinus tarsi, and cuboid bones		
Inferior tib/fib joint, tibia, mm of leg		
Anterior tibia, neck of talus, dorsalis pedis artery		

Posteriorly

Calcaneus, Achilles tendon, Musculotendinous junction		

Plantarily

Plantar muscles and fascia		
Sesamoids		

APPENDIX F

DURBAN UNIVERSITY of TECHNOLOGY

Patient Name: ***File #:*** ***Page:***

Date: ***Visit:*** ***Intern:***

Attending Clinician: ***Signature:***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***A:***

Least 0 1 2 3 4 5 6 7 8 9 10 Worst ☐

O: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***

Attending Clinician: ***Signature:***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***A:***

Least 0 1 2 3 4 5 6 7 8 9 10 Worst ☐

O: ***P:***

E:

Special attention to: ***Next appointment:***

Date: ***Visit:*** ***Intern:***

Attending Clinician: ***Signature:***

S: ***Numerical Pain Rating Scale (Patient)*** ***Intern Rating*** ***A:***

Least 0 1 2 3 4 5 6 7 8 9 10 Worst ☐

O: ***P:***

E:

Special attention to: ***Next appointment:***

APPENDIX G

Data Recording Sheet

Patient		**Age**	
Sex		**Occupation**	
Athletic category		**(non-athlete, weekend, recreational, serious)**	
Shoes worn most commonly		**(trainers, high-heels, slops, work shoes)**	
Side affected: (circle)	**L**	**R**	**Both**
Extra information			

The Visual Analogue Scale (VAS)

	Score		**Score**
Assessment 1 (week 1)		**Assessment 2 (week 1)**	
Assessment 3 (week 2)		**Assessment 4 (week 2)**	
Assessment 5 (week 3)		**Assessment 6 (week 3)**	
Assessment 7 (week 4)			

The Pressure Pain Threshold (PPT)

	Visit 1		**Mean**		**Visit 2**		**Mean**
Assessment 1 (week 1)				**Assessment 2 (week 1)**			
Assessment 3 (week 2)				**Assessment 4 (week 2)**			
Assessment 5 (week 3)				**Assessment 6 (week 3)**			
Assessment 7 (week 4)							

Weight-bearing Ankle Dorsiflexion

	Score		**Score**
Assessment 1 (week 1)		**Assessment 2 (week 1)**	
Assessment 3 (week 2)		**Assessment 4 (week 2)**	
Assessment 5 (week 3)		**Assessment 6 (week 3)**	
Assessment 7 (week 4)			

Ultrasound Evaluation of the Plantar Fascia

Date:		
	Week 1 (initial visit)	**Week 4 (follow up visit)**
Increased thickness		
Measurement: (mm)		
Comment: inflammation (hypoechoisity), tears		
Signature of ultrasonographer		

APPENDIX H

The Visual Analogue Scale (VAS)

Patient name: ____________________ File No.: __________________

Date: ______________

Please indicate on the line below, the number between 0 and 100 that best describes the pain you experience. A zero (0) would mean "no pain at all" and one hundred (100) would mean, "pain as bad as it could be." Please indicate only once.

0 _________________________________ 100

APPENDIX I

THE FOOT FUNCTION INDEX QUESTIONNAIRE

INSTRUCTIONS: Please fill in a value somewhere between **0** and **10** describing your pain
0 indicates no pain **10** indicates the worst pain
If the question is not applicable then indicate this by writing N/A next to it

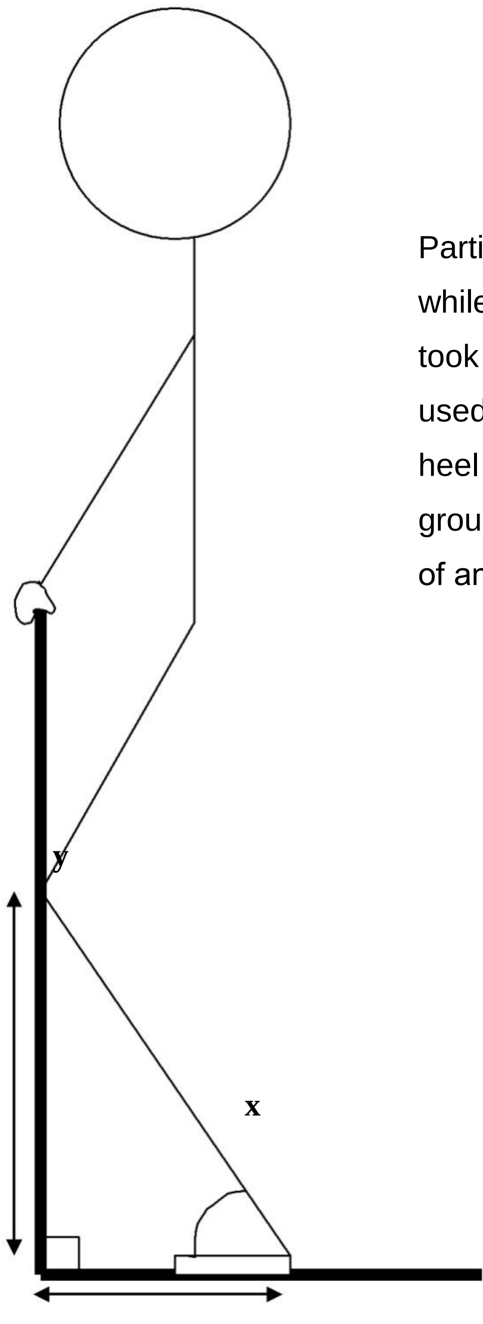
Section A: Pain	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Worst pain												
Morning Pain												
Pain walking barefoot												
Pain walking with shoes												
Pain standing with shoes												

Section B : Disability Can you	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Walk in the house												
Walk outside												
Climb stairs												
Descend stairs												
Stand on tip toe												
Get up from a chair												
Climb curbs												

Section C: Activity Limitation Do you have to?	**Yes**	**No**
Stay inside all day		
Stay in bed all day		

APPENDIX J

How the Weight-bearing Ankle Dorsiflexion measurement was calculated



Participants stood on the involved leg and dorsiflexed the ankle while flexing the knee up to a point where no further dorsiflexion took place, without lifting the heel from the ground. A set square was used to measure the horizontal distance (x) from the back of the heel to the front of the knee. The vertical distance (y) from the ground to the front of the knee was measured similarly. The degree of ankle dorsiflexion was calculated using: $\tan \theta = y / x$.

APPENDIX K

Confidentiality agreement:

This letter serves to act as a confidentiality and ethical agreement. I agree to act ethically and keep confidential any information I might learn. I will not perform any activities that may potentially affect the research process in any way. I will not alter the course of or affect the outcome of a potential patient/patient involved in the research process. I will be ethical during my use of the randomization table and will not do anything to jeopardize or influence the research process.

I, _______ agree with the above terms and conditions.

Signed ________ at___________ Date_______

APPENDIX L

DURBAN UNIVERSITY *of* TECHNOLOGY

INSTITUTIONAL RESEARCH ETHICS COMMITTEE (IREC)

12 September 2012

IREC Reference Number: **REC 22/12**

Mr J L Petzer
P O Box 2132
Umhlanga Manors
Umhlanga
4021

Dear Mr Petzer

An investigation into the effectiveness of two different taping techniques in the treatment of plantar fasciitis

I am pleased to inform you that Full Approval has been granted to your proposal REC 22/12.

The Proposal has been allocated the following Ethical Clearance number IREC 033/12. Please use this number in all communication with this office.

Approval has been granted for a period of one year, before the expiry of which you are required to apply for safety monitoring and annual recertification. Please use the Safety Monitoring and Annual Recertification Report form which can be found in the Standard Operating Procedures [SOP's] of the IREC. This form must be submitted to the IREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC SOP's. In addition, you will be responsible to ensure gatekeeper permission.

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely

[redacted]

Dr D F Naude
Chairperson: IREC

APPENDIX M

KINESIO®

#1 in Elastic Therapeutic Taping™

Certificate of Course Completion

Justin Petzer

Has successfully completed the course requirements defined by Kinesio Taping Association International, as stated below

KINESIO TAPING FUNDAMENTALS AND ADVANCED (KT1 & KT2) — COURSE TITLE

227-000-1F-110309-KTAIUK-SA — COURSE CODE

227-000-2A-110409-KTAIUK-SA — COURSE CODE

DR JENNIFER ILLES — INSTRUCTOR

03/11/09 - 04/11/09 — SEMINAR DATE

16 — HOURS

DURBAN — CITY

STATE

SOUTH AFRICA — COUNTRY

KINESIO TAPING ASSOCIATION

04/11/2009 — DATE

INTERNATIONAL PARTNERS:
Kinesio Japan
Kinesio USA
Kinesio Canada
Kinesio South America
Kinesio Brazil
Kinesio Argentina
Kinesio UK
Kinesio Spain
Kinesio Scandinavia
Kinesio Deutschland
Kinesio Poland
Kinesio France
Kinesio Italy
Kinesio Greece
Kinesio Russia
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Kinesio South Africa
Kinesio Middle East
Kinesio China
Kinesio Taiwan
Kinesio South Pacific
Kinesio Republic of Korea
Kinesio Mexico

KINESIO TAPING ASSOCIATION IS AN APPROVED PROVIDER OF CONTINUING EDUCATION BY:
+ AOTA, for Occupational Therapists. Provider # CP1211667
+ Board of Certification Inc., for Athletic Trainers. Provider # P2293
+ NCBTMB, for Massage Therapists. Provider # 450030-06
+ State PT Associations, for Physical Therapists. Provider #

The course content is not intended for use outside the scope of practice of the learner's license or regulation.

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KINESIO TAPING CERTIFICATION COURSE (KT3) — COURSE TITLE

227-000-3S-110509-KTAIUK-SA — COURSE CODE

COURSE CODE

DR JENNIFER ILLES — INSTRUCTOR

05/11/2009 — SEMINAR DATE

8 — HOURS

DURBAN — CITY

STATE

SOUTH AFRICA — COUNTRY

KINESIO TAPING ASSOCIATION

05/11/2009 — DATE

INTERNATIONAL PARTNERS:
Kinesio Japan
Kinesio USA
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